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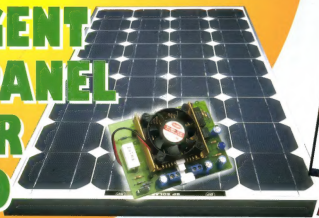

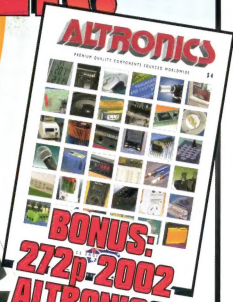

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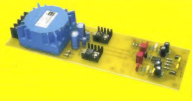

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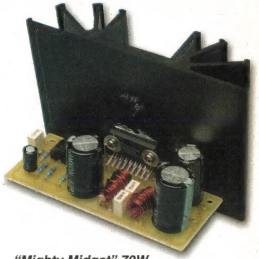

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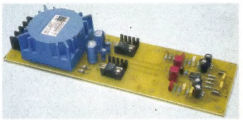

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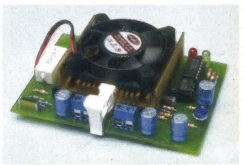

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PUBLISHER'S LETTER

Wind power is increasing in Australia

This month, we have been rather critical of the various campaigns to get domestic electricity users to install solar panels on the roofs of their homes. While the idea of promoting solar power is good, there is little justification for it if it does not have a reasonable payback period. In fact, unless you spend a lot of money on a solar system, say $15,000 or more, you are unlikely to cater for your own energy consumption let alone become a "net seller" to your local grid.

We also regard systems without battery storage as being a bit of a joke. One of the attractions of installing solar panels and the other necessary equipment is that you become independent of the local electricity supply. During blackouts, you continue to function normally. If you can't achieve that, then what is the point?

However, the renewable energy story in Australia is looking much better than it was just a few years ago. But the real advances are not being made in solar energy but in wind power. In the last two years or so, some big wind farms have been started and there are more to come. For example, there is the 150 megawatt wind farm in Portland, Victoria and the recently announced 130MW Woolnorth development in Tasmania to be run by, believe it or not, Hydro Tasmania. In fact, they have mapped out plans for 1000 megawatts of wind power.

Stage one of the Woolnorth project will comprise six 1.75MW Vestas wind turbines for an initial installation of 10 megawatts. These wind turbines are much bigger than the 600kW units installed in Australia's first grid-connected wind farm at Crookwell, in NSW. (We featured in the Crookwell wind farm in the January 1999 issue of SILICON CHIP.)

Greenpeace and AusWEA (Australian Wind Energy Association) have jointly launched an official target for Australia to install 5000MW of wind power by 2010. Given the progress so far, that certainly looks achievable.

Apart from the initial installation, wind farms cost essentially nothing to run and have minimal impact on the environment, so they must be regarded as a very good alternative to any thermal power station. Still, while 5000MW sounds like a lot of power, it is really only a small percentage of Australia's generating capacity.

And while wind power is good, what about solar power? Australia's solar power potential is far greater than wind power but virtually nothing is happening. The main reason that wind farms are being built is that they are simple turn-key projects: just pay your money and Vestas or one of the other wind turbine makers will install your wind farm quick smart. Considering the relatively small amount of money spent or committed on wind farms so far, Australia has little to boast about.

We should be committing funds to make real progress in the development of major solar power stations. Government has to get involved in a big way. Consider this: a typical coal-fired power station these days costs at least one billion dollars. What would happen if the Federal government or one of the states decided to devote one billion dollars to research and development over the next five years with the aim of building a major solar power station? We would make real progress. One billion dollars over five years is a trifling amount, considering our Gross Domestic Product.

I am sure such a project would be successful and would put Australia well on the way to eventually generating a major portion of its power from the sun. Let's do it.

Leo Simpson

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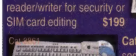

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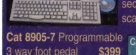

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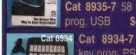

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SILICON CHIP MAILBAG

Clarification of DVD resolution

Some recent letters to the editor have suggested that DVD pictures are considerably better than VCR pictures because of the poor resolution of the latter. In particular, they have spoken of the little more than 200 lines of resolution provided by a VCR, with one letter contrasting this with DVD's 576 lines.

This requires clarification. DVDs and VCRs produce the same vertical resolution. Nominally 625 lines, some of these lines are used during the vertical blanking intervals (during which the electron beam returns from the bottom of the screen to the top). For PAL, the number of displayed lines was traditionally 585. For DVD, 576 lines was settled upon. The difference is insignificant (most displays lose several lines through overscan at both the top and the bottom).

This 580-ish horizontal lines spread over the vertical dimension is the same whether the picture is from VCR, broadcast or DVD (assuming a full screen DVD picture).

The resolution sometimes specified for VCRs is often stated as '200 lines' or maybe a little more. This is not the vertical resolution but the horizontal resolution. Rather than the pixels that have been talked about most commonly with the advent of computers, the resolution of TV pictures was traditionally specified in terms of the number of vertical lines that could be discerned across the width of the display. This is where the '200' comes from.

By contrast, DVD players are typically capable of between 500 and 540. Note that the picture on a PAL DVD is actually encoded as a 720 pixel wide by 576 pixel high image, so hardware DVD players lose around 17% of the horizontal resolution during the conversion from a digital picture to an analog PAL signal.

Stephen Dawson,
Gilmore, ACT.

Right of reply on DVD widescreen

I'm glad to see my letter in the September 2001 issue generated so much interest and comment.

What disappointed me, was I feel, most of you missed my point. My gripe was never against DVD and I never once said that DVD doesn't give a better picture than VHS. It's the film industry that manipulates the film and has the final say on how they will do it. I have already mentioned "What Women Want" and "Titanic". Now I include "True Lies" and "Airforce One". How many other movies are being done this way?

"Airforce One" was a blatant example. I acquired a Zone 1 NTSC copy of the DVD and the beauty of this one was it is double-sided, one side Widescreen 2.35:1 while the other is Full Screen 4:3. The widescreen, as you guessed, was the 4:3 picture blackbarred top and bottom; ie, 44% of the original picture removed. What really annoyed me, the blurb on the cover of this, as it does on most VHS movies, said "Film reformatted to suit 4:3". What a joke this is, when in these cases, it actually happened the other way around.

If the film makers are filming in 4:3, why are they bothering with the pseudo widescreen? As I stated in September 2001, I thought widescreen was more picture on the sides, not less top & bottom. So why would anyone in their right mind spend upwards of $4000 on a 76cm widescreen TV when you get the same result with a $2000 to $3000 80cm 4:3 set?

My point is I guess, how are movies today initially filmed and then eventually presented. Next time you go to the cinema, take a note of the trailers to up and coming movies. Most are presented in 16:9, however when they become the feature they're suddenly 2.35:1.

All you "couch potato experts" have put your two bob's worth in but I wish the real experts from the film industry would comment. Also maybe the excellent team at SILICON CHIP could explain the workings of the compression technique used on DVD and what trickery is done to get 500 lines resolution out of a 4:3 and supposedly the same from 2.35:1.

Simon Kareh,
via email.

More on transformer ratings

Congratulations on securing the copyright of EA/ETI as noted in the Publisher's Letter in the January 2002 issue.

On a different note, in reference to Ben Lowe's letter (Mailbag, January) relating to transformer ratings, I am

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afraid that I must side with Mr Lowe. Perhaps I can elaborate a bit on what he wrote.

The power rating of a transformer depends on how hot the transformer is allowed to get during use. That in turn depends on two main sources of heat: iron (eddy current) losses in the core and copper (I^2R) losses in the windings. Here, "I" represents the RMS current through any winding of the transformer and "R" is its resistance. At 50Hz we can safely assume that eddy current losses are small compared to I^2R so it is the loss due to the resistances of the primary and secondary windings that is the more important.

In any practicable transformer design there is only a limited space available in which to put the windings. If you want more power you need thicker wire (to reduce I^2R losses). This means that you need more space and hence a bigger transformer.

In general, the optimal space available for the secondary winding(s) is practically the same whether you have one secondary winding or two. If you design for a centre-tap configuration you would need twice as many turns on the secondary winding(s) as you would for a bridge configuration. This means that thinner wire must be used and the effective winding resistance would be doubled.

Imagine a transformer with two identical secondary windings. You can connect the windings in parallel for a bridge configuration or in series for a centre-tapped configuration. The parallel connection has half the resistance of the centre-tapped configuration for the same no-load output voltage. Therefore the I^2R loss under load is halved, which translates into 1.4 times as much total power for the same I^2R loss.

Although for reduced duty cycles the power loss is increased compared with the output power, the duty cycle makes no difference to the advantage offered by the bridge configuration over the centre-tapped configuration. This is because for any given duty cycle the RMS current is the same. Hence the I^2R loss for the centre-tapped configuration is always double that for the bridge configuration.

Incidentally, if you include the I^2R loss in the primary winding, which is independent of the output configuration, the advantage of the bridge configuration over the centre-tapped one is somewhat less than otherwise but the principles remain the same.

Herman Nacinovich,
Gulgong, NSW.

Officious letters not necessary

I have been away from home for some time and started to catch up on some reading, SILICON CHIP included! I was amazed at some of the correspondence and indeed the tone of some of it. I wish particularly to take issue with Mr Ian Stanley-Eyles' letter published in your November issue.

I gather by the tone of the letter that Mr Stanley-Eyles is either a civil servant or a solicitor, in whichever case there was no need for the very thinly veiled threat embodied in the correspondence, essentially demanding a legal disclaimer and suggesting that a magazine such as yours was in any way acting outside the law deliberately!

I do not believe a letter of that tone is needed in the columns of a magazine like this!

I wish also to make comment regarding the ongoing debate regarding electrical installations and who may carry out electrical work. It seems to me, as it has to others, that the arguments coming from the electrical safety authorities are nothing other than the oft-repeated views of a bunch of electricians turned civil servants trying to keep the "old boys club" going by excluding not only competent laymen, but also highly qualified technicians and engineers, from doing what they are more than capable of doing and doing, in many cases, better than a so-called qualified electrician.

The civil servants charged with the duty of public safety in matters electrical should move aside and let people do their own wiring.

Steve Newson,
via email.

Don't change electronics content

Firstly, it's great to see that SILICON CHIP has not strayed from its original philosophy with regards to content. I have been collecting (much to the anguish of my wife) all the Australian local electronics magazines since 1980 when I was studying electrical engineering at the UNSW and have been a subscriber to SILICON CHIP for a number of years now.

I was horrified when the "other" locally produced electronics magazine made a severe change of content direction. Its recent withdrawal from publication probably reflected the same opinion from other readers. I guess what I'm trying to say is that you people at SILICON CHIP are doing a tremendous job and should keep doing what you do best.

Con Andrews,
via email.

Virtues of negative feedback

I need to comment a little on your response to the reader "G. W." who asked questions about the Ultra-LD Amplifier in the February 2002 issue, page 91.

I notice that you advertise audio books by Self and Hood in the same issue, pp 86, 87. G. W. and the friends who advise him, would do well to read both of these books. Self and Hood don't always agree but their books are clear, informative, useful and fun to read.

G. W. mentions "a few people I know ... anyone can achieve low THD with lots of feedback". Many people who know a little of electronics find feed-

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back difficult and seem to want to regard it with suspicion and as an unnatural "black art". I am willing to admit that in my student days, I built quite a few amplifiers that oscillated - and oscillators that didn't. But difficulty doesn't justify suspicion.

Let me try to dispel the biggest part of the feedback myth first. Feedback is not at all unnatural; nature uses it by the truckload. Feedback is what enables us as humans to walk about on two legs. Anything tall and skinny with bendy bits in all sorts of peculiar places is unstable and this becomes conspicuous when we are drunk, asleep or dead - we fall over.

In our legs, we don't just have muscles and bones, we have umpteen nerves dedicated to monitoring what bit is pointing where. Behind our ears, we have special balance canals filled with special fluid and zillions of tiny hairs, so we can know which way is up; we also use our eyes.

When doctors ask us to stand on one leg and shut our eyes, they are checking for a certain social disease. It damages nerves and people with that disease don't get enough feedback and fall over.

Moving away from nature a little, feedback is what enables us to drive a car. Most drivers pay attention to where the car is on the road. If too far to the left, they steer to the right; if too far to the right, they steer to the left. Back to bodies: feedback is what keeps us alive. Many, probably most, of the chemicals sploshing about in our bodies are regulated by feedback systems. Too little oxygen, our heart beats faster; too much carbon dioxide, we breathe faster. Many illnesses happen when some feedback mechanism breaks down. No feedback: no us!

Let me move on to the "less feedback is better" myth. It isn't. The authoritative explanation is: P. J. Baxandall, "Wireless World", December 1978, pp 53-56. In layman's terms, a little bit of feedback can do only the easy bit: suppressing the low-order distortion components. However, it can't do the difficult bit: suppressing the high order distortion components.

Indeed, the way it suppresses the low-order ones is by turning them into high-order ones. A little bit of feedback makes things worse, not better. It is really dumb to do gross, brutal things like using Class A to reduce feedback.

The implication that "anyone can use lots of feedback" is a myth too. That is the big problem with feedback. It is necessary but difficult to use lots of it. That is why I made amplifiers that oscillated while I was a student. Feedback is much more like porridge than like sex. Like porridge, feedback needs to be "just right"; bad feedback is bad and definitely not, "better than nothing".

But getting it "just right" isn't easy. It is necessary to understand it well, to do a few moderately difficult calculations, and to do even more testing to double and triple check that it is "just right". But once it is right, then it is RIGHT, and it deserves no more suspicion than a person who can stand on one leg with their eyes shut.

Keith Anderson,
Kingston Tas.

Australian 3-pin plug and socket

I am able to provide some background to the questions posed by Dick Smith (Mailbag, Jan 2002) regarding the origin of the Australian 3-pin mains plug. The design was adopted, around 1930, as a result of a "Gentlemen's agreement" (there was no Standards Australia then) between Fred Cook of Ring-Grip, Geoffrey Gerard of Gerard Industries, and Brian Harper Miller of the SECV.

They based the design very closely on an existing American plug, and although that American design has apparently now faded into obscurity, I believe that same American design is the reason that Argentina and Chile and probably also China, also use essentially the same design. New Zealand copied the Australian design as Australian electrical appliances and equipment were exported across the Tasman.

One of the reasons behind the adoption of that particular design by the three Australian gentlemen was that it was cheap to make; the flat pins could be easily stamped out of sheet brass, in contrast to round pins or thicker rectangular ones used in other countries. This was also a consideration when the Chinese authorities officially adopted the design in relatively recent times, despite the considerable inroads the British plug had made due to its use in Hong Kong.

The Chinese made one change, however; the earth pin is at the top. This is considered to offer some protection should a conductive object fall between the plug and the socket. An interesting piece of trivia is that this is referred to in Hong Kong as the "emu foot" or "emu track" plug, as the socket when viewed with the earth slot uppermost does resemble the track of an emu.

I thank Dennis Perry and Norm Zerner (presently and formerly of Gerard Industries) and Max Steen, a former colleague of mine in the Approvals Branch at ETSA, for their help with this information.

David Inkster,
Meadows, SA.

TV for collector/restorer

I have just been given a Healing B/W valve TV set, not working due to blown input fuse. The set is in great condition and may be suitable for a collector. It is a Healing 17, with the circuit diagram in the rear indicating a Chassis 5M150-5M075-4M150-958 RUN 3.

I would hate to throw it away and would be happy to pass it on to anyone who could do something with it.

Ashley Hosking,
PO Box 73, Basket Range, SA, 5138.
Phone (08) 8390 3442.

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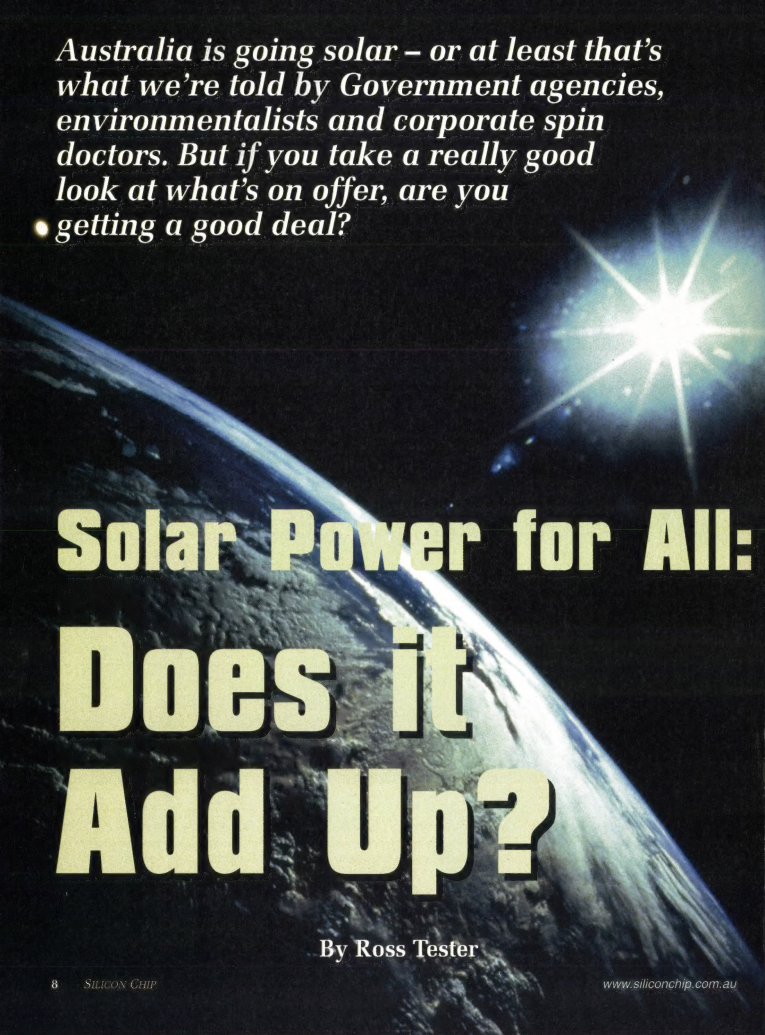
Australia is going solar – or at least that's what we're told by Government agencies, environmentalists and corporate spin doctors. But if you take a really good look at what's on offer, are you getting a good deal?



Solar Power for All: Does it Add Up?

By Ross Tester

A ten-panel "plug&power" rooftop system from Pacific Solar. This would be capable of generating 1.5kW and cost between $10,000 and $15,000. Photo courtesy Pacific Solar.

With much fanfare and breast-beating, several initiatives have been announced to convince Australians to generate their own electricity, simply by placing photo-voltaic (or solar power) panels on their otherwise-wasted roof space.

Of course, there is nothing particularly new about generating electricity from the sun. Photo-voltaics have been known about – and used – for many decades.

There are two main reasons that it has taken a recent boost in profile:

(1) "Green" is fashionable. Concern about the environment has escalated dramatically in the last decade to the point where some people are prepared to pay extra for "green" power.

(2) Perhaps even more importantly, vast improvements have been made in the efficiency of photo-voltaic cells in recent years. And with the amount of money being poured into R&D, it is expected this will continue.

Coupled with this is a very significant reduction in cost – as volumes rise, costs should continue to fall.

"Greenhouse" gases

If you say something often enough and loud enough, most people start believing it. Could this be the case with the so-called "greenhouse effect"?

The theory, albeit very abridged, goes something like this: we humans produce too much carbon dioxide. The two main culprits of CO_2 production are (of course) that evil monster, the car, along with fossil-fuel (mainly coal) burning power stations.

Problem is, no-one wants to give up their car or turn off the air conditioner!

This large amount of CO_2 acts like a one-way valve for sunlight (and therefore heat) entering our atmosphere and striking the earth. The earth heats up, which will eventually cause polar ice caps to melt which in turn will cause oceans to rise, flooding low-lying areas. Another consequence is a major change in climatic conditions.

Cut the CO_2 emissions and we'll cut the greenhouse effect. It's that simple.

The point is, it is still JUST a theory. Most people are firmly convinced it is fact, simply because there are so many people telling them it is fact. We even have Government departments and agencies set up to deal with the "problem". However, there are many experts around the world who don't believe the greenhouse effect is the one true gospel. Many refer to it as the "greenhoax" effect.

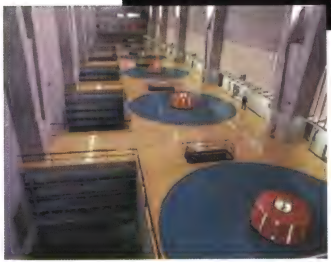
In 1995, skeptical scientists signed the Leipzig Declaration on Global Climate Change, stating that they "cannot subscribe to the so-called 'scientific consensus' that envisages climate catastrophes and advocates hasty actions".

But their voices are generally not heard amongst the incredibly sophisticated PR machine of the environmental lobby.

The greenhouse effect is taught in schools as fact. The alternative point of view – that climate change is a natural phenomenon – barely rates a mention.

Yes, there is some evidence of global climatic change. That proves the theory, of course – except that there is also evidence that the Antarctic continent is colder now than it has been since records were started! Whoops – better ignore that one!

And in the overall scheme of things, we're still only talking the blink of an eye in not just human history, but the



Wind and water: two of the most prolific and abundant forms of renewable energy. At right is Australia's largest wind farm near Albany in Western Australia. Below is the turbine hall of a hydro-electric power station. No wonder they call it "clean" power!

Courtesy Western Power.

history of our planet.

Who is right? Only time will tell. In the meantime, it does make sense to try to limit the amount of CO_2 and other pollutants entering out atmosphere from power stations – if only to make us feel better about the air we breathe!

And that's where "clean, green" renewable-energy electricity comes in.

Green power

Photovoltaic cells are not the only way to produce non-polluting electricity. There are four main ways to do it:

(a) Wind-generated power – this has started to make an impact in Australia recently with several "wind farms" established in relatively-constantly-windy areas. The advantage is that the wind is free, if not constant. One disadvantage, apart from fairly low output per generator, is reportedly the swishing noise of the blades for people living within a few kilometers!

To show just how far wind farms have come, in January this year it was announced that the world's largest wind farm, a 520MW, 200 turbine installation, would be built off the coast of Ireland at a cost of more than $1 billion. Proponents claim that wind farms will be able to produce more than two thirds of Europe's electricity by 2020.

Incidentally, the first grid-connected wind farm in Australia was opened at Crookwell, NSW in 1998. At 4.8MW it doubled the previous wind generation capacity in the country! For more information on the Crookwell wind farm, see the January 1999 SILICON CHIP.

The largest wind farm in Australia is currently the 21.6MW plant at Albany, WA, with twelve 1800kW turbines on 65m towers.

(b) Bio-energy – burns the methane gas created during the natural decomposition of organic material to drive a turbine. Several bio-mass power stations have been established on the sites of old rubbish tips, tapping into the decaying material underground. While not truly renewable energy (it must run out in time!) it is relatively non-polluting (in fact, it uses and therefore removes a potentially polluting gas).

Another form of bio-energy burns the waste material from a production process (eg, the bagasse left over from sugar-cane crushing) in a similar manner. In many instances, this also produces steam and other energy for use in the plant – so-called "cogeneration."

(c) Water-generated power – immediately, most people think of hydro-electric and for the most part (at least in Australia) they'd be right. However, the "green power" people will not allow their power to be sourced from any new dam or river diversion so this option is now, for all intents and purposes, at its peak (upgrades to existing hydro-electric facilities are allowed).

Turbo installations range from backyard, hobby types (perhaps on a stream flowing through a rural property) producing perhaps a couple of hundred watts, to giant dams with huge flows of water, producing many megawatts.

There is another source of water power, as yet relatively unknown in Australia, and that is tidal. In many places in the world (including the north-west of Western Australia) tide heights are measured in tens of metres and this inflow and outflow can be used to generate electricity via a turbine. The disadvantage is that the flow stops, builds, reaches a peak, stops, builds in the opposite direction, reaches a peak and stops again, twice every day. Due to lack of flow around high and low tide, electricity of any significant magnitude can only be generated for perhaps half to two-thirds of each six-hour cycle.

An ocean wave converter generator is reported to be currently under construction (or at least in planning) off the coast of Portland, Victoria.

(d) And, of course, solar power, where in most cases the electrical energy is created through sunlight striking a photo-voltaic cell. Until quite recently, the amount of power generated this way was either very

small or very expensive – but this is changing. It is solar power we are looking at in this feature.

Before we leave this introduction there are two other forms of solar power generation which bear mentioning.

The first is where a large "field" (perhaps several hectares) of sun-tracking mirrors (called a "heliostat") focus the sun's rays on a steam-producing boiler (usually high on a tower). This in turn drives a turbine, generating electricity. Such systems are in use overseas. The temperature at the focal point of the mirrors can be extremely high – many thousands of degrees!

The second form of solar generation, still somewhat in the "theoretical" stage but likely to appear this decade, is a huge solar-powered "chimney", incredibly tall (a kilometre or more) and 5km wide at the base. The sun heats air at the base which rushes up the chimney, driving turbines on the way. Such a project, which will have a peak output of 200MW, has recently been announced for Ned's Corner in far north-western Victoria.

But this is not quite the solar installation for a suburban house!

Solar for all

There is no doubt about it – the "push" for solar power is gaining momentum (even if the installation is not quite keeping pace).

It received quite a "kick along" prior to the 2000 Olympic Games when 629 buildings in the Olympic Village (now the suburb of Newington) as well as the 19 lighting towers on Olympic Boulevarde were fitted with solar power modules from BP Solar.

You may have seen recent television adverts supporting the "solar for schools" project – in fact, there are now more than 25 schools listed as "generators" of electricity via their solar panels.

Few, if any, would be significant net producers of power; they would use all the power they generate themselves (thereby reducing their energy bills). They are somewhat fortunate in that most, if not all, of their power demand occurs during daylight hours.

When you have large expanses of roof space (and often, in the case of schools, elevated roof space at that, away from shading of trees and other buildings) there is room to fit large numbers of solar panels.

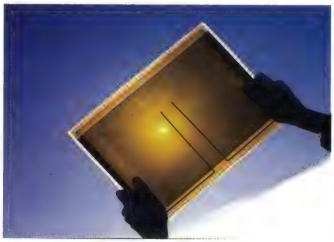
The rule is simple: the more panels, the more power. On the downside, naturally, the more panels, the higher the initial cost.

But even with a large installed solar capacity, can a school – or even a house – generate enough electricity to make it an economic proposition? You be the judge.

One product/company which caught our attention (after much media fanfare!) is "Plug&Power" from Pacific Solar. This company, by the way, is a spin-off from the University of NSW which provided the intellectual property.

The company's vision is "to have developed solar cells seen across the rooftops of the world". While this is a laudable objective, their claim that "the majority of households have enough sunshine and roof area to produce their entire energy needs" bears closer examination.

Its solar panels measure 1.68m x 0.84m (1.41 square metres). Each



One of the first modules produced on Pacific Solar's pilot-line. These 30cm x 40cm modules were sufficiently large for researchers to address most of the issues involved in scaling up technology to commercial size of up to 1m^2. Photo courtesy Pacific Solar.

The owner of this house in Sydney's inner west "is interested in a sustainable future". He chose Plug&Power because of the "low maintenance, design and modular construction". Pic courtesy Pacific Solar.

comes complete with its own inverter and is capable of generating 150W in direct sunlight mounted at the right angle on a north/north-east-facing roof.

Pacific Solar maintain that the average house in Sydney has enough roof area to allow 21 modules (29 square metres). These are capable of producing around 3.2kW (maximum).

Their examples, to give them credit, are based on a probably-more-realistic 15-module, 2.25kW system.

According to accepted figures, there is 1500kWh/kW of solar energy available in Sydney per annum. With a 95% efficient panel mounting (28° angle, north-east facing) that reduces the figure to 1425kWh/kW.

Their figures assume an annual electricity usage of about 6800kWh in a year. The 15-module system is capable of producing nearly half the annual usage (1425 x 2.25 = 3206kWh). But is that realistic? And what happened to the earlier claim of "to produce their entire energy needs?"

I know that in my own case, the 6800kWh is very much understated. My last four electricity bills shows it's closer to 10000kWh. And that's for a two-person household (albeit all-electric, with a pool).

On the face of it, to produce 10000kWh "to provide all my energy needs" I would need to have not 21 modules but 46. That's some 66 square metres of roof area which have to face the right direction – north!

Admittedly, about 30% of this energy is for hot water and you wouldn't use solar electricity to heat water (you'd simply use a solar heater). But that would take away some of my roof space . . .

What cost?

So far, we haven't looked at costs – let's do so now.

To install a solar power system, you're up for anywhere between $5000 and $30,000, depending on size (of system) and the supplier. Large systems may go even higher (we've seen quotes for $50,000). Now before you fall of your chair, it's not quite that bad because the Australia Government has a rebate program to encourage more people to install solar power.

There are various rebates depending on the size of your installation. A small installation is worth $5.00 per watt of installed solar capacity while a larger one is worth $7500 plus (in NSW) $2.40 per watt over 1500W.

The program, which is available to all owner-occupiers, runs out in 2004. There are some conditions, one of which is an agreement to keep the system running for at least five years. (Why on earth you would spend all that money and pull it out way inside its payback period beats me!)

Note that none of the grid-connected systems (as far as we are aware) have any form of storage – ie, no batteries. This means you cannot get any power from your system at night, nor anything significant when it's raining (or even heavy cloud). When it does produce power, you either use it – or sell it.

Selling your electricity

If you install a system which generates more power than you can use, in many cases you can sell the excess back to your power company. Some energy suppliers apparently do not yet have a firm policy on this but of those that do, the majority will pay you (or give you a credit on your bill) at the same rate as you currently pay for electricity.

In at least one case, it's much more generous than that: the Northern Territory's Power and Water Authority sell power to you at 12.9c per kilowatt-hour but will buy power back from you at 16.9c per kilowatt hour! Hey, let's move to Darwin!

In some cases the power companies will charge you extra to install either a special bi-directional electricity meter (normal meters cannot run backwards) or install an "outgoing" meter which is read in conjunction with your normal "incoming" meter. The first is subtracted from the second to achieve your power usage.

Payback period

Putting in a solar system is not going to make you rich in power savings. In fact, it's probably not even going to break even. Let's look at the sums:

Say the system you put in costs $20,000. Take off the full Government rebate and you're still paying more than $11,000.

If your current electricity bill is, say, an average of $200 per quarter, $11000 is equivalent to 55 quarters – almost 14 years – before you recover your investment. Take into account interest lost or paid and it's probably more like 20 years. Even discounting a tad for the pittance you'll receive in energy credits, you're still well over 18 years before it starts paying for itself.

Given that the average Australian family will move house at least once (and probably twice or more) in that

Better ways to save "greenhouse" gases

So installing a solar system on your roof may not be the way to go. But you still want to do something about reducing greenhouse gases. What can you do? There are plenty of things you can do and they will also give you a big payback in terms of reduced energy bills.

Here are some of them:

(1) Buy a new car. No, we are serious. If your car is more than ten years old, you should buy a new one, to help the environment. Can't afford a new car? Well, then you certainly can't afford "plug&power" or any other of these schemes either.

(2) Get rid of your lumbering full-size 4WD. We cannot understand how anybody who is concerned about greenhouse gases can justify driving these monstrosities. Typically, they use 80% more fuel than a big car such as a Commodore, Falcon, Mitsubishi Magna or Toyota Avalon. And full size 4WD vehicles use at least twice the amount of fuel compared to medium-size cars such as Ford Lasers, Toyota Corollas, Mitsubishi Lancers etc.

Apart from being much cheaper to drive (and therefore more greenhouse-friendly), new cars are much safer than 4WD vehicles. OK, so you want a 4WD for your bush holidays. Fine. Buy a small car and hire a 4WD during your holidays – you will still save heaps.

(3) Buy a new fridge. If you don't have air-conditioning or a swimming pool, your refrigerator's electricity use is a major part of your electricity bill. New refrigerators are much more efficient than your old unit, especially if it is more than ten years old.

By the way, put your old fridge on the next council cleanup for recycling. Don't use it as a beer fridge or give it away for the same use – you do want to see electricity saved, don't you?

(4) Get rid of your freezer. Most households simply don't need a separate freezer. You're better off using fresh meat anyway. Instead, buy the largest refrigerator which will fit into your kitchen and use the freezer compartment in that.

(5) Replace your old dish-washer. New machines use less water and consume less power. They're much quieter, too.

(6) Use gas hot water. When your electric hot water system fails, replace it with a gas system. It may not be cheaper to buy or to run, but it will produce less greenhouse gases.

(7) Use gas heating or a reverse-cycle air-conditioner for your home heating in winter. Gas heaters are far more expensive to buy than electric radiators but they produce less greenhouse gas to give the same (or more) heat. The same comment goes for a reverse-cycle air-conditioner. They cool in summer, as well.

(8) Install a solar hot water system.

This list is not comprehensive but if you really want to spend some money to reduce your greenhouse gas emissions, these are the intelligent decisions you can make.

OR you can invest your money in "green" companies. If you have lazy $5000 or more laying about, why not invest it in companies which are committed to a "green" outlook.

There are quite a few such companies listed on the Australian Stock Exchange or you can invest in an "ethical" managed fund. That way, you benefit the environment and hopefully, make a profit as well.

18 years, you will probably never get out of the red!

Can't afford a big system? Here's one being marketed at the moment: Pacific Solar's "Member's Pack". It comprises a three-module system along with a Sunlogger (keeps track of energy generated), a Sundown program for your PC and a regular newsletter.

It costs just under $6000 (and that's after the government rebate) but the one thing you can be sure of is that you won't ever generate much power to sell!

They claim this system "on average will supply enough electricity over a year to run the lights, television, video, microwave and toaster of the average house. . ."

Oh yeah?

Let's see: the three-module system at best generates 450 watts. But that doesn't happen from dawn to dusk. Nor does it happen when it's cloudy or rainy.

We mentioned the accepted figure of available solar energy in Sydney is 1425kWh/kw per annum. With the 450W system, you're going to produce 641kWh per year (.450 x 1425)

OK, so you have this 641kWh per year to play with.

Now let's see. In order – lights in an average home, say 10 rooms with an average 75W globe; 750W. Television: oh, about 250W. Video: a modern one, say 50W. Microwave: about 1000W. Toaster (even a measly little one): 800W. All that comes to a smigeon under 3000W.

Naturally, not everything is going to be on all the time. The average Aussie TV set is on for 5 hours a day. 5 hours x 365 days x 250 watts = 456kWh per annum. Most people leave their videos on constantly – 440kWh. The toaster may only get a workout for 10 minutes a day (if that) – 48kWh and the microwave perhaps half an hour a day – 182kWh. Lights, of course, vary all over the place and are usually only on for 5-6 hours a night. Let's then assume that one third of the lights will be on at any one time – say 22kWh (probably a bit conservative because most light usage will be in the kitchen/living/lounge room areas).

That's 456 + 440 + 48 + 182 + 22 or 1200kWh (1.2MWh) per annum, in round figures. Now when I was at school (it was a couple of years ago and things might have changed . . .) 1200kWh into 640kWh doesn't go (even if I did fail maths!).

So who is kidding whom?

Solar panel installations do not have to be roof-mounted. This one is on a frame in the back yard and has the added advantage of being able to turn to track the sun, keeping the angle at the optimum for virtually the whole day.

Incidentally, buying that 1200kWh from your electricity supplier at 10c per kWh will cost you the princely sum of $120. Makes the $6000 installation cost of the solar system looks pretty sick, doesn't it?

640kWh would of course cost about $64 so you're looking at a payback period of, oh, about 100 years give or take.

Of course, all this assumes that energy costs will stay around where they are now. While most fuels have risen dramatically in recent years, electricity is one which has shown admirable restraint.

Again, I remember from school in the (late!) sixties, we used a figure of 5c per kilowatt hour in maths problems. Today my power bill says I pay 9.38c per kilowatt hour – not bad for forty years of often double-digit inflation!

But that's not to say our electricity costs will not increase in the future: they probably will. Then there may be some better cost justification for domestic solar power.

Costs of the solar panels themselves will almost certainly continue to fall. Not only due to costs of production but also due to the huge amount of R&D investment, solar panels will not only get cheaper in the future, they will get more efficient at converting the sun's energy into electrical energy.

And Pacific Solar, among others, are getting pretty excited about thin film solar panels which are expected to start appearing about the middle of this decade. This second generation PV technology is expected to more than halve the cost of manufacture.

While we're talking of the future, let me throw this one in: all the reading I've done on this subject tells me that heat is one of the biggest problems with solar panels. So why not produce a solar panel which is water cooled – presto, a solar water heater built into the photovoltaic panel? Sounds feasible, don't you think?

Another random thought (I have plenty of those): it seems to me that cladding a roof (with tiles, iron, etc) then placing the solar panels above that is a waste of roof cladding. Why not make a solar panel which IS the roof cladding?

But I digress . . .

The environment

Most of the "case studies" I have read involve a significant environmental commitment on the part of the homeowner installing solar power. They wanted to "do their bit" for the environment and were willing to pay to do it.

Australians today are generally much more environmentally conscious than their parents or grandparents. In those days there was scant information about the environment; there was even less effort to improve it.

Today, that's all changed. We recycle our garbage as much as possible. We try not to pollute our waterways. We're conscious about dirty car exhausts. And so on. People today get a "warm and fuzzy" feeling about doing the environment good.

Even if they are sometimes misinformed or even misguided, that doesn't hurt anyone and may leave the planet a better place for our children!

If you believe in the greenhouse effect and want to minimize CO_2, fair enough. Each Plug&Power module installed (or similar product from other suppliers) prevents almost 250kg of CO_2 from being generated in a coal-fired power station each year. Wow! (Yes, I am being facetious . . .)

A 10-module installation (1.5kW) will save over 60 tonnes of CO_2 over the system's 25-year life.

Again, in the overall scheme of things this isn't going to achieve much at all. There are much better ways to reduce energy use and therefore "save the environment" (see separate panel).

Despite the intense efforts of the Government and industry to promote solar energy for homes, the Australian Bureau of Statistics has indicated recently that the use of renewable energy, especially solar power for domestic purposes, has actually declined.

Perhaps consumers are thinking more with their wallets than their hearts? **SC**

References

(These are just some of the websites where you'll find information on solar power for the home. Google "solar power" and you'll get thousands more!)

Pacific Solar ("Plug&Power" is their trademark). www.pacificsolar.com.au
BP Solar: www.bp.com/bpsolar
Western Power (WA): www.westernpower.com.au
Citipower (Melbourne): www.citipower.com.au
Energy Australia (Sydney): www.energyaustralia.com.au
An excellent educational site for school projects, general information, etc: www.env.qld.gov.au/sustainable_energy/publicat/
Links to *hundreds* of solar power sites: www.pv.unsw.edu.au/solpages.html
The "Greenhoax" effect: www.geocities. com/Yosemite/7915/Greenhoax.html (or Google "Greenhoax effect")

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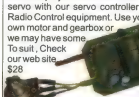

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PANASONIC KX-TS85ALW telephones were used during the 2000 Olympics. Lots of features inc. speed dialler, Hands Free Volume Control, Call Waiting, Ringer Indicator, Call Forward, Dial lock, Redial, Recall. You will find these as a newly introduced product in a Major Australian Electronics dealers catalogue for $161. Manual is not supplied but can be downloaded from our web-site(KXTS85)

(Used) The Citizen iDP3530 Printer:

These Printers are in excellent condition and are made in Japan. They come with basic software, a Brand New Paper roll and a Ribbon. The Citizen printer is a rugged Point of Sale Printer with a serial interface. It is capable of being used on A wide variety of hardware platforms, not confined to a std PC. This opens up a range of other uses such as Capturing call details on a PABX, Logging data from a Weather Station or recording the Performance of a Solar Water Heater. Any equipment with a standard RS232 port is capable of utilising this printer. $99

(NEW) HOTDOG JUNIOR SOFTWARE: This Web Page Creation Software is Brand New in original packaging. Inc. two CDs, one Hotdog Junior CD for Web Page creation & the other CD has 50,000 Clipart Objects. This software helps you create & publish your first Web Page in four basic steps. It is designed for children 8 years & up but it can also be used by adults (beginners). We are selling this software for a fraction of it's retail price. Check out http://www.sausagetools.com/products/ for more info(ZB0320) $11 ea

(NEW) SOUND BLASTER LIVE! 5.1 SE AND BOSTON ACOUSTICS DIGITAL ENTERTAINMENT

This special edition is supplied with the PCI card, Software on CD and leads to connect the card to a CD-ROM. Visit the creative website for further information. These are brand new in their retail packaging. A manual is not supplied but can be downloaded The card has a digital output suitable for driving the Boston Acoustics sound system: (SBDE51) $100 These cards can only be purchased with a Boston Acoustics sound system. Previous purchasers of the Boston Acoustics sound system may also Purchase these cards.

$169

AS REVIEWED IN THIS MAGAZINE

ROBOT BUILDERS BARGAIN!!!

RADIO CONTROL CAR / TRUCK REAR AXLE (DIFERENTIAL) ASSEMBLEY Complete drive assembly from a model car including wheels, gearbox and a 380 motor. The wheel diameter is 9.5 cm and the distance Between the outside wheels is approximately 24 cm. As used in some Tandy Electric cars. We have a good quantity in stock for a Small fraction of Their retail price. (MRC1) $13 each

Type supplied may differ from the one shown.

VIDEO SYNC. STABILISER KIT: BACK IN STOCK

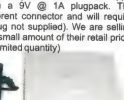
Various forms of copy protection are used on Video tapes & DVD's, the problem is that this changes the normal signal and may cause playback problems such as jitters. This device removes the copy protection by stripping and reinserting the sync. pulse and thus cleaning the picture.
This items comes as a Ready built PCB. The Case shown in the picture & 9V battery are not Supplied. The 9V battery Connector will need to be Soldered to the PCB.
KIT PRICE: (K176) $29

30 LED IR ILLUMINATOR KIT:

Illuminates Night Viewers or CCD Cameras using 30 of our 880nm / 40° IR leds which have 35mW output. These leds have a forward Voltage drop of 1.65V & a water clear lens. Operates from 12V DC at Approx.300mA. The leds are arranged into 6 strings of 5 leds in series. PCB Measures 78 x 49mm (Replaces The lid of our Hb1 small Plastic box available Separately).
KIT PRICE: (K102) $20

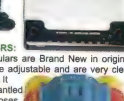
(USED) 33.6K HAYES ACCURA MODEM:

Why get a 56K Modem when most telephone lines only allow up to 33.6K? These 33.6K Hayes ACCURA 336 External Modems are in good condition. We supply these modems with a 9V @ 1A plugpack. The plugpack has a different connector and will require changing (correct plug not supplied). We are selling these modems for a small amount of their retail price: (ZB0302) $22 each (limited quantity)



DELUXE BINOCULARS:

These 3 x 22 Binoculars are Brand New in original packaging. These are adjustable and are very clear with a resolution of 3x. It can also be fully dismantled for experimental purposes. These Binoculars are excellent for watching cricket, tennis and any other sports. ZB0334 $2 (pack of three)



(NEW) PROVIEW FRESNEL LENS:

These Fresnel Lens are Brand New and and can be used as a rear window lens for backing & driving safety. The lens enables you to actually see many things you cannot see through your inside rear mirror or side mirror - greatly increases the angle of vision. Also a great experimental item. Dimensions are 7" x 10": (ZB0303) $3 each

CAMBRIDGE SOUNDWORKS COMPUTER SPEAKERS

We have a limited quantity of these Cambridge SoundWorks GCS300 Computer Speakers. These are Brand New in original packaging that includes two speakers with power supply, cables, and manual.

Response: 90 - 20kHz...
Amplifier Gain: 12dB @ 1KHz volume max...
Output Power: 92 dB SPL at . 5m listening position...
Power (each satellite): 2 Watt...
Input Impedance: 10K ohms...
Controls: On/off/master Volume on right speaker...
Weight: 1.5Kg per speaker set including adapter...
Dimension: 153X101X114mm ..(GCS300): $22 - limited quantity.

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LOW PRICE COLOUR CMOS CAMERS WITH FREE VHF MODULATOR

Just watch this space or check our web site for more details

ULTRA-VIOLET LEDS!!!

LEDS AND LASERS

395nM UV LED's...

200mCD	$4.70

Blue LED's

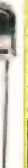
3.5CD	$3.50

White LED's

6CD	$2.50
10CD	$4
15CD	$6

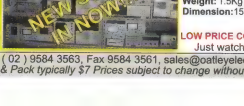
650nM LASER MODULES

3mW	$18
6mW	$36
10mW	$90



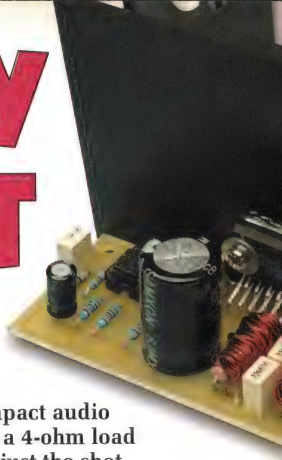
MORE NEW STOCK

We have more used test equipment coming all the time and we need to clear stock to make way for the next lot. The only way to make sure you don't miss out is to subscribe to our bargain corner & receive advanced notice by E-Mail Just send us a blank E-Mail to.... bargaincorner-subscribe @oatleyelectronics.com



MIGHTY MIDGET

A COMPACT 70W CLASS-H AUDIO AMPLIFIER MODULE



Based on a Philips TDA1562Q IC, this compact audio amplifier module can deliver up 70W into a 4-ohm load when powered from a 12V car battery. It's just the shot for use in a portable PA, a tiny sub-woofer amplifier, a busking amplifier or a car audio amplifier.

By RICK WALTERS

OUR NEW MIGHTY MIDGET Amplifier can really pack a punch – around 36W RMS continuous into a 4-ohm load when using a 13.8V supply. However, it's the 70W of output power that it can deliver during dynamic (music) signal conditions that really make you sit up and take notice.

As can be seen from the photos and the circuit diagram, the Mighty Midget uses just a handful of parts. It's built on a PC board that measures just 104mm x 39mm but while its size may be modest, these's nothing at all modest about its power output. And the noise and distortion figures are pretty good too.

At the heart of the circuit is the TDA1562Q IC, described by Philips as a "monolithic integrated Bridge-Tied Load (BTL) class-H high-efficiency power amplifier". It comes in a 17-pin "DIL-bent-SIL" plastic package and is not only designed for use in car audio and portable PA work but for mains applications as well; eg, mini/midi audio components and TV sound.

Specifications

The specifications panel and the accompanying graphs show the performance of our prototype, as measured on our Audio Precision test gear. Note that the total harmonic distortion is typically less than 0.2% at 1kHz for output powers up to about 16W RMS, while the signal-to-noise ratio is better than 95dB unweighted (22Hz to 22kHz).

The frequency response is virtually ruler flat from 28Hz to 55kHz.

PERFORMANCE

Output power: 36W RMS into 4Ω

Music power: 70W into 4Ω

Frequency response: -1dB down at 28Hz and 55kHz

Input sensitivity: 130mV RMS (for 36W into 4Ω)

Harmonic distortion: typically 0.2% (see graphs)

Signal-to-noise ratio: >95dB unweighted (22Hz to 22kHz)

Pumping it out

So how does it achieve such high output powers when powered from a 13.8V rail? Well, it employs a few clever tricks. Let's take a closer look.

First, the TDA1562Q chip actually incorporates two power amplifiers in its package and these are operated in bridge mode to boost the available output power. Fig.1 – the block diagram of the TDA1562Q IC – shows the general idea.

Normally, if we have just one amplifier stage operating from a 13.8V supply, the maximum power that can be delivered into a 4Ω load is about 6W. The reason for this is that the maximum voltage "swing" possible from a 13.8V supply is 6.9V in the positive direction and 6.9V in the negative direction. This is equivalent to

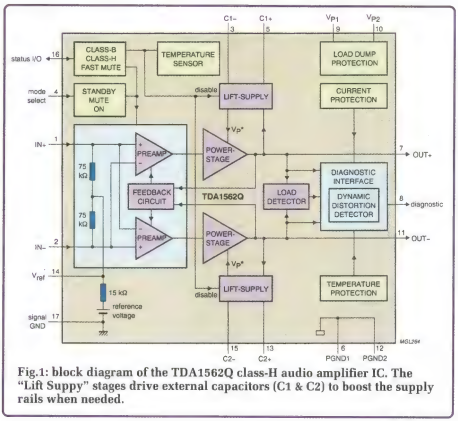


Fig.1: block diagram of the TDA1562Q class-H audio amplifier IC. The "Lift Suppy" stages drive external capacitors (C1 & C2) to boost the supply rails when needed.

about 4.88V RMS (ie, 6.9/1.4142).

From there, the mathematics is simple enough – the power output is equal to the square of the RMS voltage divided by the load resistance; ie, $P = V^2/R$. This means that we get 4.88 x 4.88/4, or about 5.95W RMS.

However, this is a theoretical maximum and is never realised in practice. The actual output power is likely to be closer to 4.5W RMS due to losses in the output devices of the amplifier.

One way of obtaining more power is to wire two identical power amplifiers in "bridge" mode, with each amplifier essentially a "mirror" of the other. One amplifier drives one side of the loudspeaker in a positive voltage direction, while the other drives the other side of the loudspeaker in a negative voltage direction. As a result, the voltage across the loudspeaker is effectively doubled compared to the voltage delivered by a single power amplifier.

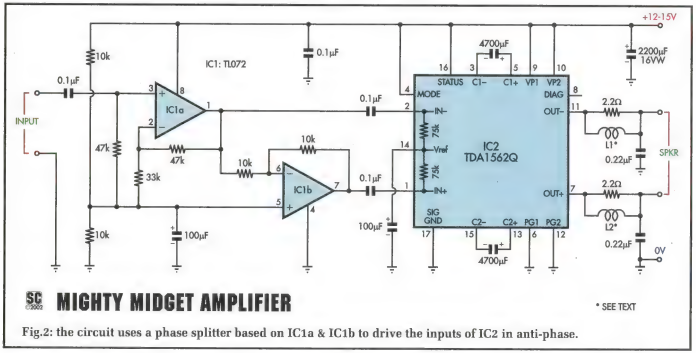


Fig.2: the circuit uses a phase splitter based on IC1a & IC1b to drive the inputs of IC2 in anti-phase.

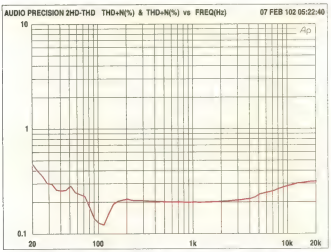


Fig.3: total harmonic distortion (THD) vs. frequency at 12W (measurement bandwidth 10Hz-80kHz). The dip at 100Hz is due to cancellation with supply ripple.

Fig.4: total harmonic distortion vs. frequency at 36W (measurement bandwidth 10Hz-80kHz). It's less than 0.5% for frequencies from 30Hz to 10kHz.

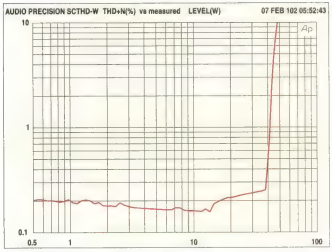


Fig.5: total harmonic distortion vs. power output at 1kHz (measurement bandwidth 22Hz-22kHz).

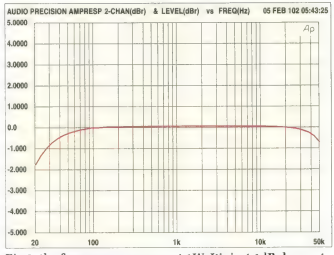


Fig.6: the frequency response at 1W. It's just 1dB down at 28Hz and 55kHz.

This doesn't just double the power output, though. Instead, as shown by the above formula, doubling the voltage swing effectively quadruples the output power! So if we use two amplifiers which on their own can deliver only about 4.5W into 4Ω, we can expect to obtain about 18W RMS into the same load when they are connected in bridge mode.

And 18W RMS is a "helluva" lot better than 4.5W RMS.

Jacking up the supply

That's by no means the end of the story, though. As previously stated, the TDA1562Q is capable of delivering 36W RMS and up to 70W of music power.

How does it do this? Well, according to Philips, at low output powers, up to 18W, the device operates as a normal BTL amplifier. However, when a larger output voltage swing is required, the internal supply voltage to the power amplifiers is "jacked up" by using the "Lift-Supply" stages to switch in two external electrolytic capacitors – see Fig.1.

There are no details in the specifications as to how the "Lift-Supply" stages work but we assume it's a type of boot-strapping circuit whereby each of the two power amplifiers in the bridge circuit actually "jacks up" an external 4700μF capacitor to increase the effective supply voltage.

Normally, the external electrolytic capacitors are switched across the 13.8V supply and charge to about 12.8V (ie, about 1V less than the supply rail). When extra power is required, these capacitors are boosted up by the respective power amplifiers so that ultimately, the supply voltage is almost doubled.

As a result, the amplifier module can briefly deliver much greater output power – up to 70W of music power or up to 36W RMS (ie, continuous power) as previously mentioned. Of course, it cannot maintain 70W of output power for long. The two external capacitors immediately begin to discharge when the amplifier is delivering this sort of power and so the supply rails quickly falls again.

On practical music signals, however, this isn't normally a problem, as the electrolytic capacitors are quickly switched out and charged again between the signal peaks.

Class-H or Class-G?

Philips refer to this scheme for operating the power amplifiers as class-

H operation. In class-H operation, the input signal is monitored and the supply rail is constantly adjusted to provide just enough voltage for optimum operation of the output devices.

By contrast, class-G operation involves monitoring the input signal and switching the output stage between two different supply rails, as required. In this scheme, the (class-AB) output stage is normally connected to the lowest rail and automatically switches to the higher rail for large signal peaks.

So which of the two schemes is it? Philips label the TDA1562Q as a class-H amplifier and we are inclined to agree with this although we still don't know the exact mechanism of the "Lift Supply" circuitry. No matter – which ever label is used, it's very effective at boosting the output power.

Another advantage of class-H (or class-G) operation is that it reduces dissipation in the output stages by about 50%. That's because the output stages operate at low voltage for most of the time when the amplifier is driven by music signals. This means that the heatsink size can be greatly reduced.

By the way, all switching from class-AB to class-H operation (and vice versa) takes place at zero crossing points of the input signal. This is done to eliminate switching artefacts, which could otherwise cause distortion in the output signal. It's a very effective technique – we could find no traces of switching noise whatsoever.

A rugged device

Another good thing about the TDA1562Q is that it is virtually indestructible (within limits). It's output stage is short-circuit proof (either to ground, the supply rail or across the load) and it features thermal overload protection, good supply ripple rejection and static discharge protection.

There are also no switch-on or switch-off plops and the output is automatically muted if the supply voltage drops below the minimum operating level. The thermal overload protection works by automatically switching the device from class-H to class-AB operation if its case temperature exceeds 120°C. This basically disables the high-voltage supply and thus limits the output power to less than 20W.

Circuit description

Refer now to Fig.2 for the complete circuit details of the Mighty Midget Amplifier. Apart from the TDA1562Q itself (IC2), there is a dual op amp IC (IC1), two air-cored inductors and a few resistors and capacitors.

Op amps IC1a and IC1b together function as a phase splitter. These stages are necessary to provide a differential input to the amplifiers in IC2, both of which have their inputs at pins 1 & 2.

As shown, the input signal is fed to pin 3 of IC1a. This functions as a non-inverting amplifier with a gain of 2.4, as set by the 47kΩ and 33kΩ feedback resistors (ie, Gain = 1 + 47/33). Its output is AC-coupled to pin 2 of IC2 via a 0.1μF capacitor and drives IC1b which is wired as an inverting unity gain amplifier.

IC1b in turn drives pin 1 of IC2 via a 0.1μF capacitor. As a result, the signal on pin 1 is inverted (180° out of phase) compared to the signal on pin 2 and so we get true differential drive to IC2, with a gain of 2.4 for each input. The input impedance for each pin is 75kΩ (with respect to Vref) and so the low-frequency rolloff with 0.1μF input capacitors is about 20Hz.

Parts List

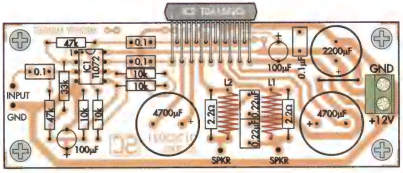
1 PC board, code 01203021, 104 x 39mm
1 1-metre length of 1mm-dia. enamelled copper wire
1 heatsink (eg, Jaycar HH-8566 & HH-8572; DSE H-3460; Altronics H-0560 & H-0522)
2 2-way PC-mount screw terminal block (5.08mm pitch)
4 PC stakes
2 15mm x 6BA machine screws
2 6BA nuts
4 6BA washers
Heatsink compound

Semiconductors
1 TL072 dual FET op amp (IC1)
1 TDA1562Q BTL power amplifier (IC2)

Capacitors
2 4700μF 16VW PC-mount electrolytic
1 2200μF 25VW PC-mount electrolytic
2 100μF 25VW PC-mount electrolytic
1 0.33μF MKT polyester
4 0.22μF MKT polyester
1 0.1μF monolithic ceramic

Resistors (0.25W 1%)
2 47kΩ
4 10kΩ
1 33kΩ
2 2.2Ω 1W

Bias for IC1a & IC1b is provided by a voltage divider consisting of two 10kΩ resistors. The resulting half-supply voltage (Vcc/2) is then filtered using a 100μF capacitor and is directly connected to pin 5 of IC1b. It also biases pin 3 of IC1a via a 47kΩ resistor and this ensures that pin 1 swings symmetrically about Vcc/2.



L1,L2: 20 TURNS 1MM ENAMELLED COPPER WIRE ON 5MM-DIA MANDREL (SEE TEXT)

Fig.7: follow this layout diagram when installing the parts on the PC board. Make sure that all polarised parts are correctly oriented.

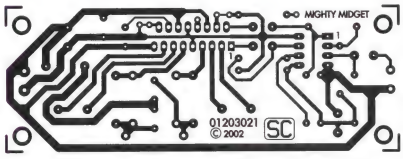


Fig.8: this full-size etching pattern for the PC board (code 01203021).

IC2 operates with a nominal fixed gain of 20 or 26dB. Its two internal amplifiers amplify the signals on pins 1 & 2 and in turn provide out-of-phase (mirror image) signals to drive the bridge tied load (BTL). This BTL consists of a loudspeaker which is fed via two Zobel networks, each consisting of a 2.2Ω resistor and a parallel 880nH inductor.

The Zobel networks present a resistive load to the amplifier at high frequencies and ensure stability. They also help reduce transient and RF interference, which can be picked up by the loudspeaker leads, from being fed back into the early stages of the amplifiers via the feedback paths.

The two external capacitors for the "Lift Supply" blocks each have a value of 4700µF. This value determines the low-frequency power roll-off.

Pins 4 and 16 of IC2 have been tied high in this circuit. Pin 4 (Mode) must be tied high for normal operation – tying it low places IC2 into "standby" mode (effectively switching it off), while leaving it open circuit mutes the output by suppressing the input signal.

Pins 8 (Diag) and 16 (Status) are normally used in conjunction with a microcontroller to monitor various parameters. For example, the "Dynamic Distortion Detector" inside the TDA1562Q can detect the onset of clipping and this information is fed to the diagnostic output. It could then be processed to drive a DC-volume control to attenuate the input signal accordingly and so limit the distortion.

Similarly, the diagnostic output can indicate various short-circuit and temperature conditions. It can either be left open-circuit or tied to the +12V rail via a 10kΩ resistor. The Status pin (pin 16) is tied high to ensure that the amplifier operates in class-H mode.

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
0.33µF	330n	334
0.22µF	220n	224
0.1µF	100n	104

PC board assembly

All the parts for the Mighty Midget Amplifier are accommodated on a PC board measuring 104mm x 39mm and coded 01203021. Fig.7 shows the assembly details.

Before mounting any parts, first check your PC board for etching defects or undrilled holes by comparing it with the published pattern (Fig.8). This done, you can start the assembly by fitting the wire links, the resistors and the MKT capacitors. The two 100µF capacitors can then go in, taking care with their polarity.

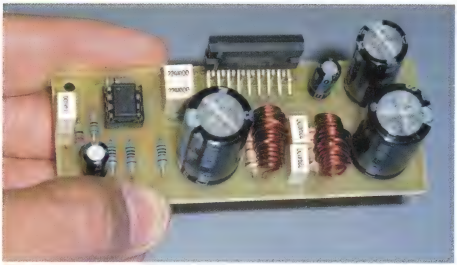
Table 1 shows the resistor colour codes but it's a good idea to also check them using a multimeter. That's because some of the colours can be difficult to decipher.

The next step is to wind the two inductors that are used in the Zobel networks. These are made by winding 20 turns of 1mm enamelled copper wire onto a 5mm former (eg, a 5mm or 3/16-inch drill). Note that you will have to wind the last five or six turns back over the winding, so that the inductor leads line up with the board mounting holes.

Because of space restrictions, the inductors are mounted proud of the PC board, so that they sit clear of the 2.2Ω resistors. Clean and tin the ends of the leads before soldering them in position. That done, fit the screw terminal block for the supply connections, followed by PC stakes for the

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
2	47kΩ	yellow violet orange brown	yellow violet black red brown
1	33kΩ	orange orange orange brown	orange orange black red brown
4	10kΩ	brown black orange brown	brown black black red brown
2	2.2Ω	red red gold brown	red red black silver brown



This close-up view shows the prototype PC board. The final version (Fig.7) has been amended to include a screw-terminal block for the supply connections and also features improved component spacing (especially near the inductors).

The TDA1562Q is secured to the heatsink using two 15mm x 6BA machine screws, nuts & washers. This also provides sufficient support for the PC board.

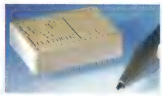
signal input and loudspeaker terminals.

IC1 & IC2 can now be installed and the PC board fitted to the heatsink. Make sure that IC1 is installed the right way around, with pin 1 adjacent to the 47kΩ resistor. IC2 can only go in one way, so there's no chance of confusion here.

The next job is to drill two holes in the heatsink to match the mounting holes at either end of the TDA1562Q. That done, deburr the heatsink mounting holes using an oversize drill and smear the mating surface of the TDA1562Q with heatsink compound. The assembly can then be bolted together using two 15mm x 6BA machine screws, nuts and washers.

You can now complete the assembly by fitting the three large electrolytic capacitors but watch their polarity – electrolytic capacitors have a nasty habit of exploding if installed the wrong way around. These capacitors are all left until last to avoid accidental damage and, in the case of the centre 4700µF unit, to ensure access

The Tiger comes to Australia

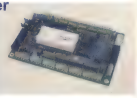


The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

TIG505 Single Board Computer



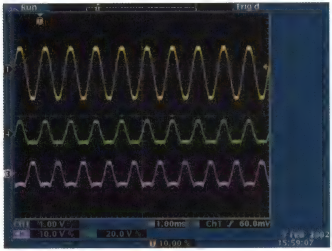
The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.

Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Victoria, 3155
Ph. 03 9762 3588, Fax 03 9762 5488
www.jedmicro.com.au



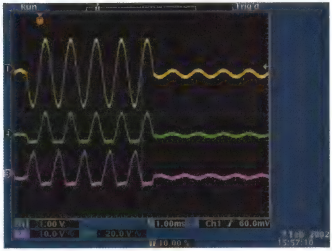


Fig.9 (above left): the top trace shows the continuous output from the amplifier terminals at 36W into 4Ω. The lower two traces show the individual amplifier outputs which add to give the final BTL output. Fig.10 (above right) shows the same test conditions as for Fig.9 but with a music-power signal at 70W into 4Ω.

to the lefthand mounting screw for the TDA1562Q.

Note that pin 4 (Mode Select), pin 8 (Diag) and pin 16 (Status I/O) have been brought out to vacant pads. These are not used in this circuit.

Testing

To test the amplifier module, you will need a regulated power supply with an output of 12-15V DC (eg, a car battery or a 12V SLA battery). Be sure to connect it to the terminal block with the correct polarity.

Note: a car battery charger can NOT be used as a DC supply for this amplifier module. That's because battery chargers deliver significantly more than 12V (they have to in order to charge) and also because they don't include any filtering.

Initially, you should connect your multimeter – set to a DC current range – in series with one of the supply leads. This done, switch on and check that the current consumption is somewhere in the range of 110-150mA. If you don't get this, switch off immediately and check for wiring mistakes.

After that, it's simply a matter of connecting the loudspeaker and feeding in an audio signal to confirm that it works.

Note that if you are using a mains power supply to drive the module, it may lack sufficient output current capability for the amplifier to deliver full power during transients. In fact, a low-current supply could even activate the muting circuit in the TDA1562Q, due to the supply rail falling below about 8V.

In practice, to drive the amplifier to full power, the power supply will need to be able to deliver at least 6A.

Note too that car electrical systems normally don't run at 12V. Instead, most run at 13.8-14.4V when the motor is running. The Mighty Midget Amplifier is designed to handle this but don't push the supply voltage beyond about 16V – you'll exceed the ratings of the 4700μF electrolytic capacitors if you do.

Speaker requirements

You can use a huge variety of speakers with this module – even low-power speakers can be used as long as long you don't wind the wick up to far!

The main thing to note is that the TDA1562Q is designed for use with 4Ω speakers and will deliver maximum power into 4Ω. Most car audio speakers are rated at 4Ω for this very reason. Of course, the amplifier will also quite happily drive an 8Ω loudspeaker. The drawback is that you will only get half the power output compared to driving a 4Ω speaker.

Finally, there is a common misconception that large speakers require more power to drive than small speakers. This is not usually the case – large speakers are usually more efficient than small speakers of similar rating and will therefore sound louder when driven by the same amplifier. **SC**

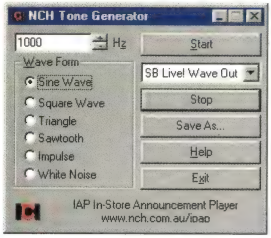


Fig.1 (left): the NCH Tone Generator is easy to drive and can generate a range of waveforms from 1Hz to about 20kHz.

Fig.2: below: the selected tone can be saved to disk as a .wav file with selectable duration. This make it easy to create a test CD ROM with various tones.

Generate tones using your PC's sound card

Looking for a simple yet versatile tone generator that won't break the bank. If you already have a PC with a sound card, this one's for free!

By GREG SWAIN

Audio tone generators are very useful gadgets when it comes to setting audio levels and for testing audio circuits and loudspeakers. However, provided your requirements are fairly modest, you don't need dedicated hardware. Instead you can use your PC's sound card to generate a range of audio tones.

After all, why pay out big bucks when you can make a PC do the work for you? All that's required is a suitable program to make the sound card do its stuff.

Fig.3: tones that have been saved to disk as .wav files can be played back using media players such as Winamp or the Windows Media Player (WMA).

One such program is "NCH Tone Generator" – a freeware utility from NCH Swift Sound. It works with all flavours of Windows, including Windows 3.1 (remember that?), Win95/98/Me, Windows NT and Windows 2000. You can obtain a copy from their website at www.nch.com.au/action/index.html and downloading tnsetup.exe (208KB).

Double-clicking this archive file automatically creates a folder called NCHTONE on your C: drive and extracts and installs three files: nchtoner.exe (the executable), nchtone.hlp (the help file) and uninst.exe (so that you can later uninstall the software). In addition, a shortcut to the program is placed in the Start menu.

Firing up

Running the software brings up the dialog box shown in Fig.1. You select the output waveform you want by clicking the "radio" button next to it, while the required frequency is entered either by directly typing it in or by clicking the "+" and "-" buttons. The tone output is started or stopped by clicking the Start and Stop buttons.

If you have more than one sound card in your PC, you can select which

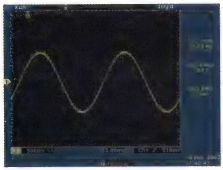


Fig.4: 100Hz sinewave (1.8V pk-pk).

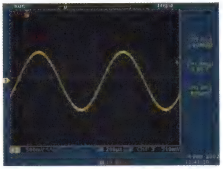


Fig.5: 1kHz sinewave (1.8V pk-pk).

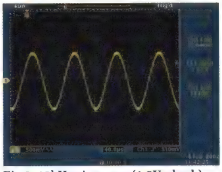


Fig.6: 10kHz sinewave (1.8V pk-pk).

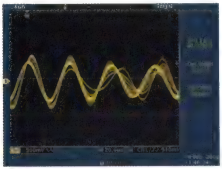


Fig.7: 20kHz sinewave (1.62V pk-pk). Note the jitter in the waveform.

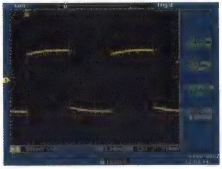


Fig.8: 100Hz square wave (2.66V pk-pk).

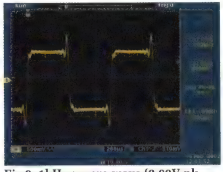


Fig.9: 1kHz square wave (2.69V pk-pk).

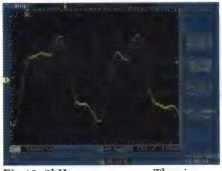


Fig.10: 5kHz square wave. The rise and fall times are quite poor.

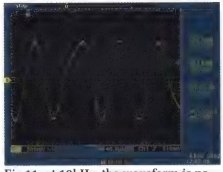


Fig.11: at 10kHz, the waveform is no longer square.

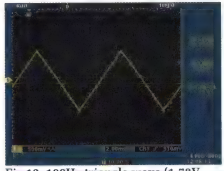


Fig.12: 100Hz triangle wave (1.78V pk-pk).

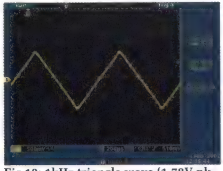


Fig.13: 1kHz triangle wave (1.78V pk-pk).

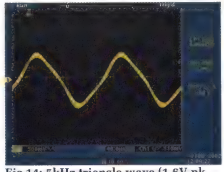


Fig.14: 5kHz triangle wave (1.6V pk-pk).

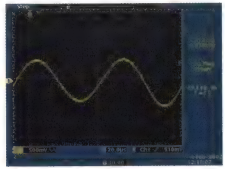


Fig.15: at 10kHz, the waveform is not triangular and varies in amplitude.

one is used to play the sound from a drop-down list.

As shown in Fig.1, the available waveforms are: sinewave, square wave, triangle, sawtooth, impulse and white noise. The valid frequency range is from 1Hz to 20kHz (1-20000) but note that the frequency setting is irrelevant if white noise is selected.

Once you've selected the waveform, you can use the Line Out from your sound card to drive external audio equipment in the normal manner. The output level can be adjusted using the mixer settings for the sound card – just double-click the speaker icon on the Taskbar to do this.

Note that the program remembers

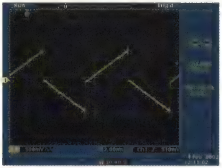


Fig.16: 100Hz sawtooth (2.22V pk-pk).

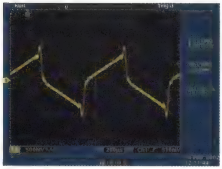


Fig.17: 1kHz sawtooth (2.17V pk-pk).

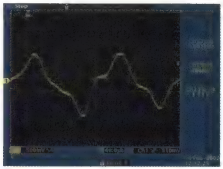


Fig.18: at 5kHz, the waveform is not much like a sawtooth.

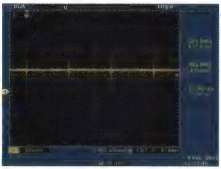


Fig.18: the 100Hz impulse waveform. The scope measured it at 200Hz.

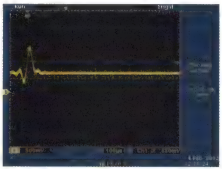


Fig.19: the same waveform as Fig.18 but expanded in timebase.

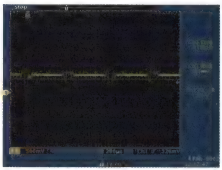


Fig.20: the 1kHz impulse waveform. The scope measured it at 1.8kHz.

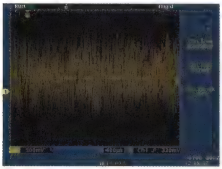


Fig.21: this is the output from the soundcard in white noise mode.

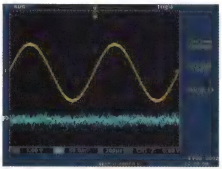


Fig.22: this scope shot shows the sinewave and its distortion products.

the current settings when it's shut down, so that they are automatically loaded next time. How does it do this? – simple, it writes the shut-down values to an "ini" file (tone.ini) which it stores in the Windows folder and then looks these values up the next time the program loads.

Keyboard control

In addition to using the mouse, you can also drive the program using your keyboard. The keyboard shortcuts are as shown in Table 1.

Unlike using the mouse, you can quickly "pan" from one end of the frequency range to the other by holding the keyboard keys down. This can be useful if you want to "slide" up and down the frequency range in semi-tone steps but it all happens too quickly to be of any real use for the one octave steps.

Performance

We were interested to check out quality of the tones, so we hooked our Audio Precision test gear up and took a few measurements. The sinewave distortion was pretty good, at just .01% THD at both 1kHz and 5kHz, measured with a bandwidth of 22Hz to 22kHz. Figs.4-22 show some of the waveforms, as captured on a Tektronix TDS 3014 colour oscilloscope.

Saving files

There's just one more feature that we haven't mentioned and that's the ability to save the selected waveform on the hard disk as a ".wav" file. This allows you to record a range of preset tones which can later be played back by utilities such as Winamp or the Windows Media Player.

Fig.2 shows the dialog that appears when you click the "Save As" button in the NCH Tone Generator utility. It automatically assigns a filename that reflects the type of waveform selected and its frequency and allows you to set the duration. By default, the file is placed in the NCHTONE folder but if a new folder is specified, it subsequently saves all files to this new location until it's changed again. SC

Table 1: Keyboard Controls

Key	Function
Enter	Start
Esc	Stop
+	Increase Frequency One Semitone
-	Decrease Frequency One Semitone
Ctrl+	Increase Frequency One Octave
Ctrl-	Decrease Frequency One Octave

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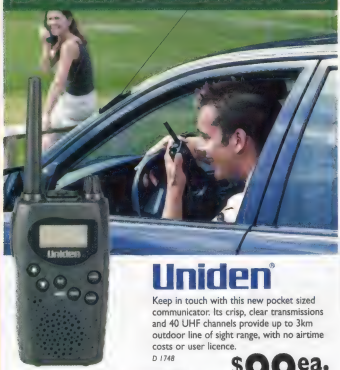

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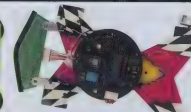

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Audio/Video Generator

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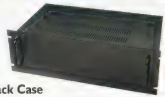

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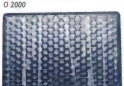

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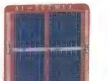

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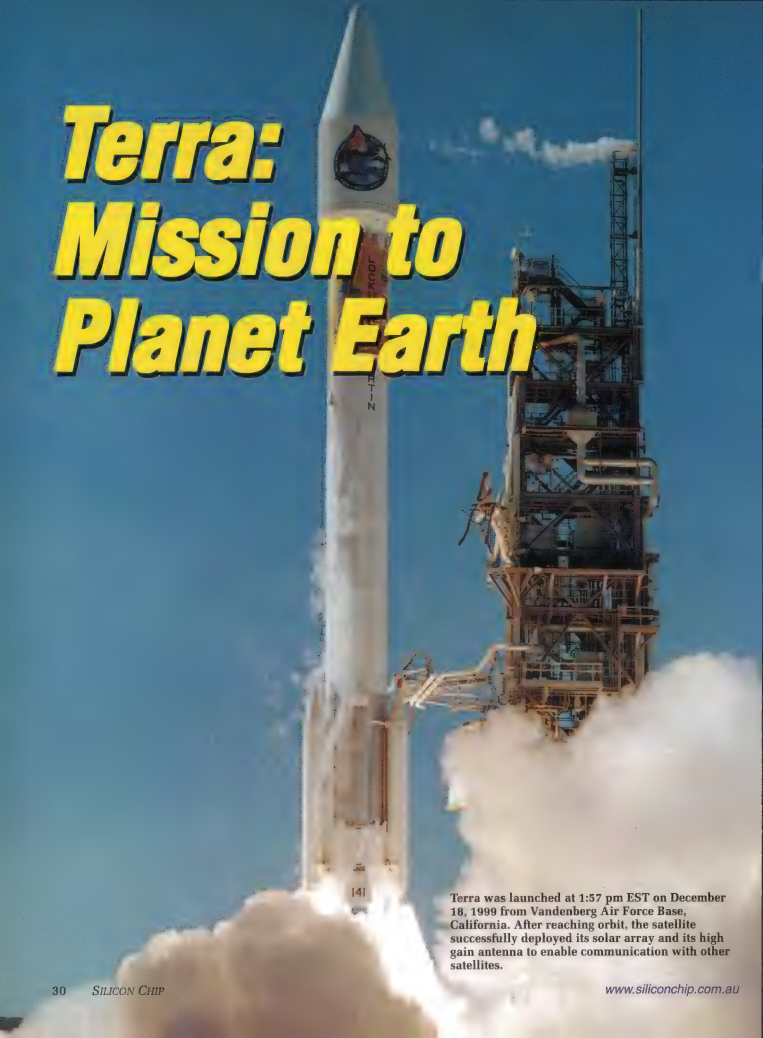
Terra: Mission to Planet Earth



Terra was launched at 1:57 pm EST on December 18, 1999 from Vandenberg Air Force Base, California. After reaching orbit, the satellite successfully deployed its solar array and its high gain antenna to enable communication with other satellites.

By SAMMY ISREB

The recent NSW bushfire crisis has been one of the worst such events in Australia's history. The intense media coverage included astounding NASA satellite photos showing the enormity of the situation. Space it seemed, gave the ultimate testimony of the ravages of the fires. So how exactly does the amazing technology behind these images work and what benefits does it provide?

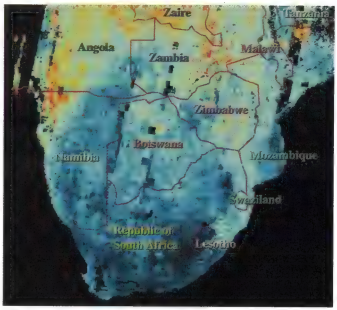
SINCE ITS BEGINNINGS in 1958, NASA has focused not just on space exploration but also on the furthering of scientific knowledge regarding planet Earth. With so much unknown about the factors effecting the climate on Earth, NASA embraced Earth System Science, a field encompassing meteorology, oceanography, biology and atmospheric sciences.

In the early 1990s, NASA commenced what is known as the Earth Science Enterprise, a detailed study into the Earth as an environmental system. The Earth Science Enterprise is composed of three main components: a series of satellites, an advanced data storage and processing system and various teams of scientists working to analyse the data.

On the 18th of December 1999, the first of the Earth Observing System (EOS) series of satellites was launched. The Terra satellite, formally known as the EOS AM-1, was built at a cost of over US$1.3 billion by Lockheed Martin Missiles and Space. The 5190kg Terra circles the Earth at an altitude of around 705 kilometres, with a polar orbit of inclination of 98°.

This orbit is specifically designed to descend southwards over the equator at 10:30am (local time), at which time cloud cover is usually at its daily low. Terra orbits the Earth once every 99 minutes. During the 6-year initial duration of Terra, its orbit will be periodically adjusted to maintain its integrity (once per orbit).

Five state-of-the-art instruments make up the scientific payload of Terra. These are used to generate an integrated snapshot of the Earth which is far superior to anything available from previous orbital remote sensing techniques. Dr Grassem Asrarm, NASA's Associate Earth Science Director, commented that Terra "has nearly unlimited potential to improve scientific understanding of global climate change".



This map shows the abundance of airborne particulates, or aerosols, over Southern Africa during the period August 14 - September 29, 2000. Low particle concentrations are shown in shades of blue, high concentrations in shades of red. These results were generated from MISR imagery acquired over this time period and processed using MISR's automated software system. The approach for deriving aerosol amount makes use of the variation of scene brightness and contrast as a function of observation angle. Black areas over the land area correspond to places where a result was not obtained; eg, due to the presence of clouds. Extensive burning of grass and shrubland for land management and agriculture comprises a principal source of these aerosols. Vegetation availability increases northward, hence the greater abundance of haze and smoke in Angola and southern Zaire. The lower aerosol abundance around Lesotho and southeastern South Africa is consistent with the higher terrain elevations near the Drakensberg Mountains.

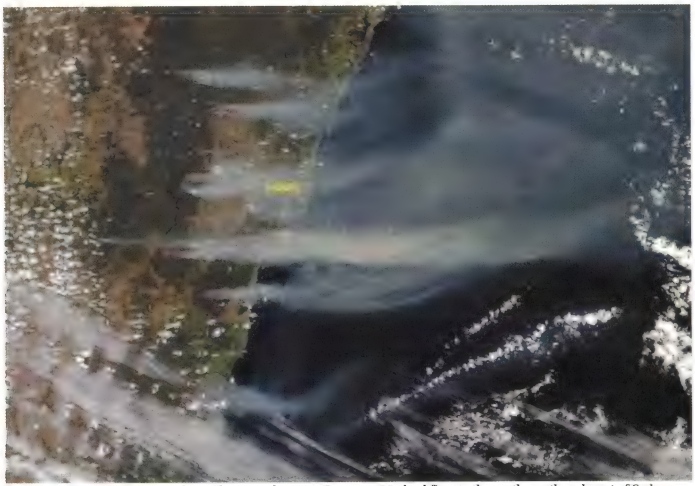
Let's now have a look at the five different measurement systems on Terra.

CERES – measuring radiation balance

The two "Clouds and the Earth's Radiant Energy System" (CERES) instruments aboard Terra provide the most accurate global radiation measuring system ever, allowing in-depth insight into the Earth's radiation balance. Everything, from plants, animals and even the Earth as a whole, emits energy, some of which leaves the Earth.

This provides a balance against the incoming energy from the Sun, maintaining a consistent climate. Knowledge of this radiation balance and the factors which affect it, is essential for understanding and modelling the Earth's climate, both now and into the future.

The CERES units are essentially scanning radiometers operating at three discrete channels. The first of these is a shortwave channel for measuring reflected sunlight, ranging from 300nm - 5μm in wavelength. The second, longwave, channel, is designed to measure Earth-emitted thermal radiation in the 8-12μm region. The third channel provides a total radiation measurement



Smoking! – this MODIS image shows the December 2001-January 2002 bushfires to the north, south and west of Sydney.

between wavelengths of 0.3 - 200μm.

Data from the CERES units is ideally suited to some of the following applications:

- Determining the effects of solar radiation as an input to global atmospheric models.
- Extended range weather predictions.
- Increasing our understanding of long-term climatic change.

MISR – nine cameras, four wavelengths

With the majority of remote-sensing satellite instruments either aimed directly towards the Earth or towards a fixed point in the atmosphere, much information regarding the effects of energy scattering within the atmosphere has been overlooked. The Multi-Angle Image Spectroradiometer (MISR) instrument was designed to address this need through the use of nine cameras. One is aimed straight down and there are fore and aft pairs angled at 26.1°, 45.6°, 60.0° and 70.5° from the Earth's surface.

As Terra orbits, the Earth's surface is progressively mapped by each of the nine cameras in four wavelengths: blue (446nm), green (558nm), red (672nm) and infrared (866nm).

MISR is able to acquire a global picture around once every nine days. Operating only during the day due to its visible light requirements, the 149kg instrument draws an average of 72W power and produces an output stream averaging 3.3 megabits/second. Built by Jet Propulsion Laboratories for NASA, the MISR has already provided a good insight into monthly, seasonal and long term trends of the following:

- The amount and composition of atmospheric aerosol particles, both man-made and natural.
- The amount, type and heights of cloud cover around the world.
- The composition of land surface cover, including vegetation density, health and structure.

MODIS – measures infrared

The Moderate-Resolution Imaging Spectroradiometer, built by Raytheon (previously Hughes), Santa Barbara, is designed to provide a broad range of observations of the Earth's atmosphere, land and oceans, in both the visible and infrared regions, with the ability to construct a global snapshot over a two-day period.

MODIS features a viewing width of 2330km over 36 separate spectral bands, ranging from 0.4 to 14.4μm wavelength, with spatial resolution ranging from 250 - 10000 metres.

Operating 24 hours a day, MODIS collects data from all spectral bands during daylight hours. In darkness, scanning is solely done in the thermal infrared bands, reducing the output data stream from 10.8Mbps (day) to 2.5Mbps (night). The 274kg MODIS draws an average of 162W of power. Typical applications of MODIS include:

- Surface temperature monitoring of both land and sea.
- Global detection of fires (including fires in underground coal seams).
- Ocean colour, to aid detection of contaminants (sediment, photo-plankton, etc).
- Cloud characteristics.

MOPITT – measures pollution

The rather lengthily named "Measurement of Pollution in the Troposphere" (MOPPIT) instrument is designed to increase understanding of the Earth's lower atmosphere and its interaction with the land and seas. In order to achieve this, MOPPIT focuses on the distribution, transport, sources and sinks of carbon monoxide and methane in the Earth's lower atmosphere.

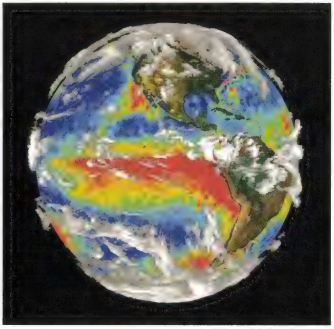
MOPPIT consists of a scanning radiometer using gas spectroscopy to measure reflected radiance in the three absorption bands of carbon monoxide and methane. By measuring the power levels of reflected spectra at 2.3μm (methane) and 2.4 and 4.7μm (carbon monoxide), MOPPIT will be able to determine the concentrations of these gases within the troposphere.

The 184kg MOPPIT was supplied to the Terra team by the Canadian Space Agency. To date, the unit has been generating global maps of carbon monoxide and methane distribution.

ASTER – for high resolution images

A joint venture between NASA and Japan's Ministry of International Trade and Industry, the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) has provided high resolution images of the Earth during its operation. Operating three distinct telescope systems, ASTER includes the following spectral subsystems: visible near infrared (VNIR), shortwave-infrared (SWIR) and thermal infrared (TIR). Each of these subsystems employs its own instrumentation and was constructed by a different corporation. The ASTER as a whole provides spectral separation to its three units via bandpass and dichroic filters.

NASA's Terra spacecraft is now providing daily views of fires around the world. With the high resolution and sensitivity of the Moderate-Resolution Imaging Spectroradiometer (MODIS) and the instrument's regular global coverage, Terra is providing an improved fire-detection capability over previous space-based sensors. MODIS is also capable of much higher-resolution imaging of fires, as seen in this image of fires in northern Australia taken on October 2, 2000.



This globe shows data collected from multiple sensors and integrated into one image. Notice the three-dimensional cloud measurements; these are collected by ASTER and MISR aboard NASA's Terra spacecraft, while MODIS measures total cloud cover on a daily basis. The El Nino temperature anomaly is visible as red in the Pacific Ocean while the red dots on land show the locations of forest fires. Terra's ASTER, MISR, MODIS, and MOPITT instruments are all uniquely-designed to observe fires and help measure the smoke and gases they release. Together with CERES, Terra's instruments help scientist's understand the Earth as a whole, integrated system.

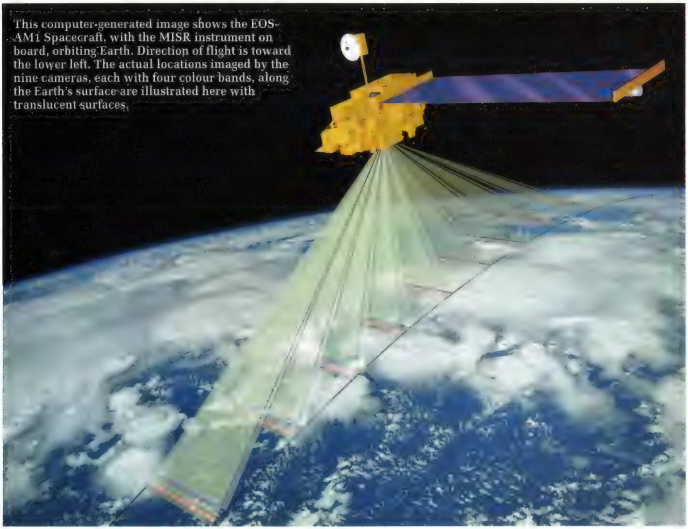
The VNIR subsystem was constructed by NEC and consists of two telescopes, one pointing downwards and one pointing behind (along the orbit path) to produce stereo images with a very high (15 metres) resolution. These images can later be used to generate 3-dimensional perspectives of the land being analysed. The wavelengths captured by this instrument are especially useful in monitoring the health of crops and vegetation.

The SWIR subsystem, produced by Mitsubishi Electric, operates in six shortwave infrared channels with a 30-metre resolution. Employing a pointing mirror, the SWIR system can focus on nearby areas of interest, allowing it to study the same area with each orbital pass for several passes. The SWIR system is especially useful for identifying the geological structure of the land being studied.

The TIR subsystem, supplied by Fujitsu Ltd, scans five thermal infrared channels with a resolution of 90 metres. As with the SWIR system, a mirror setup is used to allow areas of interest to receive higher coverage. Once again, this apparatus is especially useful for geological sensing of ground structure.

ASTER weighs in at 450kg and is the largest of the Terra's five instruments. Together, the three subsystems combine to give the ASTER the following capabilities:

- Surface temperatures and emissivities.



This computer-generated image shows the EOS-AM1 Spacecraft, with the MISR instrument on board, orbiting Earth. Direction of flight is toward the lower left. The actual locations imaged by the nine cameras, each with four colour bands, along the Earth's surface are illustrated here with translucent surfaces.

- Digital elevation (topological) maps from stereo images containing geological information.
- Surface composition and vegetation maps.
- Mapping of polar ice movements and formations.
- Mapping of volcanic activity, both geological and thermal.

Power and telemetry systems

Terra, like many satellites, is powered by an array of solar cells. Together with a nickel-hydrogen battery bank, the power system provides an average of 2530 watts of power to the craft. All data recorded by Terra is transmitted back to Earth via the Ku-band (15.25 - 17.25GHz) at a rate of 150 Megabits/second. Command and configuration information is uploaded to Terra via the S-band (1.7 - 2.3GHz). For each Earth orbit, two 12-minute periods of radio contact are used for these data transfers.

Terra global studies

As already mentioned, each of the instruments aboard Terra produces separate data sets. It is the combining of the results of several of these instruments by teams of scientists from varied disciplines that is the exciting part of this story. Currently, there are many studies being undertaken using data generated from Terra, with the fire fighting tools demonstrated during the NSW bushfires being just one of these.

Volcanoes, fire and flood

Volcanoes and fires around the world not only pose a huge threat to the safety of people and property but also generate a large amount of atmospheric aerosols. Using the MODIS instrument, Terra can scan globally and instantly produce alarms from fires or volcanic eruptions from anywhere in the world. One of the EOS teams currently produces constant lists of fires and lava flows globally, which are quite useful for risk management and evacuations.

Floods are also a major danger to communities around the world. Based on data sourced from Terra, scientists now have quite accurate models to help predict an area's susceptibility to flooding. When severe flooding occurs, researchers are able to measure the land area affected, contributing basin area, peak discharge, suspended sediment concentration and meteorological factors, so that the risk can be minimised in the future.

Vegetation

Terra is able to provide valuable data on the health and distribution of ground vegetation around the world.

With immense areas of forests being constantly turned into farmland, the Earth's climate is definitely affected. Scientists are able to use data from the ASTER, MODIS and MISR instruments in studying the impacts of climate change of global vegetation, in addition to providing large scale analysis of agricultural methods.

Researchers from The University of California, use the MODIS to monitor the burning of forest land in the Amazon and Africa. These burning activities release carbon dioxide, carbon monoxide and methane, along with other aerosols into the atmosphere. The MODIS can be used to measure the exact quantities and compositions of these gases, as well as vegetation regrowth and change later on down the track.

Cities have great impact on the local environment. Dense city planning results in higher summer temperatures, increased health risks, energy consumption and pollution levels. The instruments onboard Terra are able to assist urban planners in minimising these effects. In fact, since Terra's launch, studies have shown that vegetation cover and surface albedo (reflectivity) of urban areas have major affects on air temperatures and ozone pollution levels.

General climatology studies

Over the last century there has been an immense impact from human development on the Earth's landscape. Despite carbon dioxide levels having increased by almost one third since recording began, global temperatures have only increased by around 0.5°C over the last century – rather less than predicted by traditional climate models.

This has revealed limitations in the ways traditional models took in the effects of atmospheric aerosols, changes in cloud cover and the Earth's oceans in affecting climate.

Aerosols are tiny particles suspended in the atmosphere. While some occur naturally, human activities have increased atmospheric aerosols by around 10%. Naturally occurring aerosols include material from volcanoes, dust storms, forest fires, biological materials and sea spray. Common human aerosols include materials from the burning of fossil fuels, factories and motor vehicles.

While there is still much to be learnt, it is known that aerosols have both direct and indirect effects on the Earth's climate. The direct effect is the cooling of the Earth by reflecting incident sunlight back into space, with the magnitude of this dependent on the type and size of the particles in question. It is known that aerosol cooling from human-generated particles offsets some of the effects of carbon dioxide produced global warming.

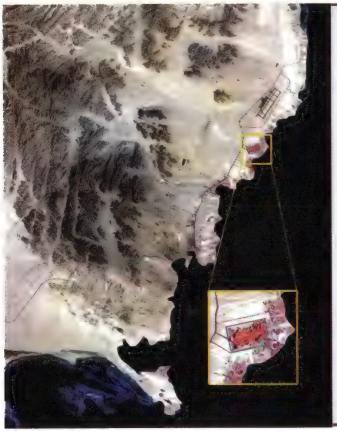
The indirect effect of these particles is to change the properties of clouds, themselves formed by water droplets adhering to aerosol particles. In regions of low particle densities, clouds tend to be composed of large droplets, with regions of high aerosol concentrations having clouds composed of very small droplets. Large droplets do not scatter light well and allow more light to pass through, while clouds of small droplets (caused by lots of aerosols) scatter light and restrict light passed towards the Earth. Also, these brighter, more reflective clouds composed of smaller droplets are less likely to generate rain than larger droplet types.

This is an artist's rendition of the MISR instrument in cutaway view. The back ends of the nine MISR cameras appear as yellow cylinders. In this orientation, MISR would look down toward Earth.

This is the "business" end of the MISR instrument, which includes the cameras and calibration equipment. The photograph was taken in October 1996, as MISR was being assembled. Subsequently, the parts that supply power, communications and temperature control were added. The entire package was then encased in a protective housing, which was covered with highly reflecting thermal blankets.

Using the MISR instrument, scientists have been able to improve their understanding of the concentrations of aerosols in the atmosphere and their effects on cloud formation, sunlight reflectivity, ground and ocean temperatures and rainfall.

With oceans comprising around 70% of the Earth's surface, this mass of water stores large amounts of heat energy. While originally thought to be a large inert "heatsink", later studies have revealed the ocean to be a



The Red Sea golf resort in Sharm El Sheik, Egypt, where President Clinton met with Israeli Prime Minister Ehud Barak and Palestinian Authority President Yasser Arafat, stands out against the desert landscape in this image acquired by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on August 25, 2000. This image of the southern tip of the Sinai Peninsula shows an area about 30 x 40km in the visible and near infrared wavelength region. The vegetation appears in red while the blue areas in the water at the top and bottom of the image are coral reefs. The airport is visible just to the north of the golf resort. ASTER is the only high resolution imaging sensor on Terra and its primary goal is to obtain high-resolution image data in 14 channels over the entire land surface, as well as black and white stereo images. With a "revisit time" of between 4 and 16 days, ASTER will provide the capability for repeat coverage of changing areas on Earth's surface. The broad spectral coverage and high spectral resolution of ASTER will provide scientists in numerous disciplines with critical information for surface mapping and monitoring temporal change. Example applications are: monitoring glacial advances and retreats, monitoring potentially active volcanoes, identifying crop stress, determining cloud morphology and physical properties, wetlands evaluation, thermal pollution monitoring, coral reef degradation, surface temperature mapping of soils and geology, and measuring surface heat balance.

An artist's impression of Terra on its way to orbit, following its launch from Vandenberg Air Force Base, California, on December 18, 1999.

major contributor to climatic phenomenon. With heat escaping the ocean and creating atmospheric temperature gradients in the surrounding air, winds are generated, creating horizontal currents.

Water temperature measurements

With temperatures and salt levels affecting vertical currents, complex water circulations around the world arise. This results in warm surface waters moving poleward where heat escapes more readily to outer space, while cold, deep currents are established in the ocean depths. Through this system of ocean circulation, the oceans and atmosphere work together to distribute heat and regulate climate. This circulation transports enormous amounts of heat, resulting in more moderate climates on land areas that are near the ocean.

Using Terra's instruments, scientists have been able to measure ocean surface temperatures to within 0.5°C. This information, coupled with wind measurements made on Earth, have been invaluable in understanding the effects of the world's oceans on global climate.

With better understanding of most of the variables which affect climate, researchers have been improving a set of tools for the prediction and assessment of the effects of large scale seasonal climate fluctuations, including the El Nino Southern Oscillation index.

The Future

Since its launch in December 1999, Terra has provided invaluable data concerning the Earth's natural processes. If all future missions are as successful as Terra, a lot will be learnt about our wonderful planet. **SC**

THE ITSY-BITSY USB LAMP

Have you ever been in the delves of a computer and wished you had some extra light? Here's a great little USB-powered lamp which you can build in next-to-no-time.

Words by Ross Tester
From an original design by Stan Swan

Many readers will remember a commercial product of a few years ago, the "Itty Bitty Book Light". It was designed to clip over the top of a book to give just a tiny light on the page when, for example, you were reading in bed and didn't wish to disturb your partner.

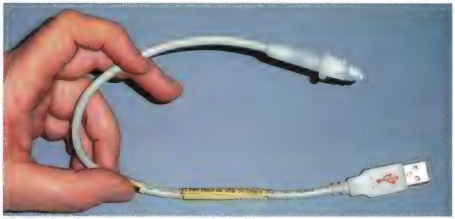
Times have changed. Now we're all working with computers. Many's the time I've been trying to look deep inside a computer and wished it was a bit brighter so I could read type numbers, see plug and socket orientations, check board seating, and so on.

Sometimes, even a torch won't work because it's too big to get really deep down. You can't get that light where you ***really*** need it.

Well, here's the answer. We've called it the Itsy Bitsy USB Lamp. It is such a delightfully simple idea we're wondering why no-one ever thought of it before.

It started life (and continues) as a student project at Massey University in Wellington, New Zealand – and in fact was submitted to us by the lecturer, Stan Swan.

When we say simple, we mean it: just a USB plug on a suitable length of cable, a superbright white LED and a series resistor to limit LED current. The LED and resistor are housed in an in-line fuseholder (without its innards!) which makes a superb little "wand" and also protects the electronics, such as they are.



Here's what the Itsy Bitsy USB Lamp looks like: one end has an ultrabright LED wired to a cable attached to a USB plug. It is as simple to build as it looks!

You'll be surprised by the amount of light you get from the LED, especially if you spend a little bit more and buy one of the really superbright (8000mCd) models (eg, DSE Z-3982). A cheaper, though lower light output (2000mCd) is the Z-3980. The difference in price is significant, though: $8.95 vs $3.95.

Of course, you don't have to use a superbright white LED. In fact, you don't HAVE to use a white LED at all. This circuit will operate quite happily with any colour and any brightness LED – but you will probably be very disappointed with the light output of most LEDs. For best results, we really do recommend the superbright white types. Yes, they're more expensive but you get what you pay for!

The USB Port

In all modern computers, you will find at least one, usually two and often four USB ports. USB stands for Universal Serial Bus, and is one of the latest incarnations of methods to get information in and out of your computer.

An ECU (that's technical talk for extra close-up) of a USB plug. It's a male plug which fits into the female USB socket on the computer.

(For more details on the USB port, refer to the article in the November 1999 SILICON CHIP).

We're not particularly interested in information transfer as such. But we are interested in the fact that the USB port offers power to external devices - +5V is available on pin 1 (0V on pin 4).

Up to 100mA is available from the USB port – far more than we need for this little application. That's the reason for the series resistor. A 47Ω resistor will limit the current to about 25mA – just about ideal.

Construction

The first thing you will need is a USB cable with at least one male plug on it. These are becoming fairly common and you should be able to pick one up for just a few dollars. A local computer shop has a 1m USB extension cable for $6 but you could well do better than this at computer fairs, swap meets, etc.

Here's a tip: get together with a mate and buy a male-to-male USB cable. Cut the cable in half and you can both build an Itty Bitty USB Lamp for half the cost!

Strip back about 5cm of the outer insulation and shield from the "bare" end of the USB cable.

Normal USB cables have four wires: red, white, black and green (as well as the shield). The green and white carry the data – we don't need them so they can be trimmed right back (make sure the wires inside their insulation are not exposed at all).

A tiny length of heatshrink tubing over the ends of the green and white wires will ensure that there cannot be shorts, either to themselves, to the shield wire or to the red or black wires.

Carefully bare about 2mm of the insulation on the red and black wires.

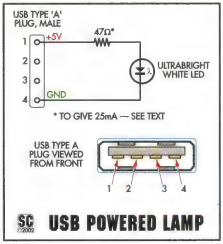
Before we go too much further, open up the in-line 3AG fuse holder and remove the wires and spring inside. All we want are the two plastic bits. Slide the longer of the two pieces over the end of the wire, smallest end first. (You may need to drill or ream out the hole a little to accommodate the wire but don't go overboard! Similarly, this

Here's the business end of the lamp, fully assembled. The LED just pokes its head through the cable hole in the fuseholder.

might be necessary on the other bit of fuseholder to accommodate the LED when we come to it shortly.)

The photograph shows this well. Slide the fuseholder down far enough so it is out of the way.

Cut the anode lead (the longer lead) of the bright white LED to about 3mm long. Similarly, cut both leads of a 47Ω 1/4W (or even 1/8W) resistor to about 3mm long and carefully solder one lead of the resistor to the anode of



It's not exactly rocket science. . . but it's often the simplest of ideas that are the best.

the LED. The 47Ω resistor will have a colour code of yellow, purple, black, gold (or yellow, purple, black, gold, gold if it's a 5-bander). It can be soldered either way around.

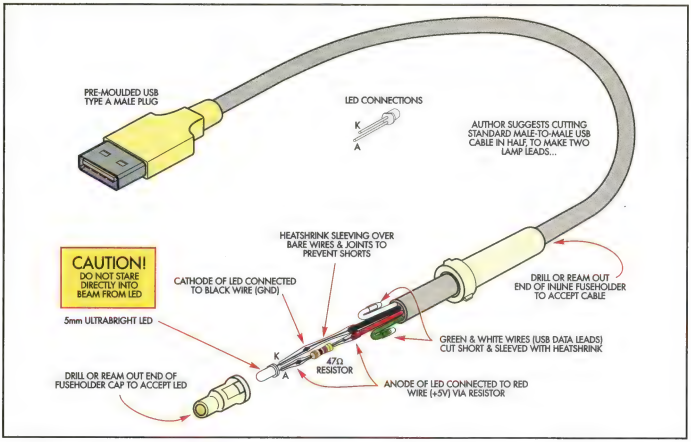
Cut a length of spaghetti insulation (or some tiny plastic tubing) long enough to cover the resistor and its leads, then slide this over the resistor so the connection to the anode is completely insulated. Heatshrink tubing may also be used for this purpose, but is not essential.

Cut another two short lengths of insulation (say 5mm) and slide them over the red and black wires of the USB cable. Solder the red wire to the resistor end and the black wire to the LED cathode. By the way, spaghetti insulation is not pasta . . .

Now slide the 5mm lengths of insulation over the solder joints – it is important that the bits cannot short out to each other when scrunched up

Parts List – USB Lamp

- 1 USB male plug moulded to suitable length 4-way screened cable
- 1 Ultrabright White LED (preferably at least 2000mCd) (eg, DSE Z-3980, 3981, 3982, etc)
- 1 3AG in-line 2-part plastic fuseholder (eg, DSE P-7912, Jaycar SZ-2015, etc).
- 1 47Ω 1/4W or 1/8W resistor
- Lengths of thin diameter heatshrink (preferably) or spaghetti insulation



inside their fuseholder "home".

Strictly speaking, this assembly should be fused in case of a short but even it there is a short the USB port will limit the current available. So no fuse! (But it's better not to have a short anyway!).

Testing

Before going any further, check and check again that everything is as it should be. Most of all, make sure that there is no possibility of any shorts from one lead of the USB cable to another – particularly the green and white (data) wires. (Failure to do this could damage your computer).

With your computer on, plug the USB plug into the USB socket. If everything is OK, the white LED should glow brightly. If not, check for shorts or open circuits.

Final assembly

Slide the fuseholder back up the USB cable, pushing everything inside it until only the LED and abut 3mm of its leads are emerging.

Slide the other end of the fuseholder (the shorter end) onto the longer piece so that the LED just pokes the top of its head out the hole (flush with the hole is fine).

Twist the fuseholder end onto its body to lock it in place.

And that's it. Now when you need a bright light anywhere around your computer – all you have to do is plug it in to the USB port!

The labels

You might have noticed two labels on the cable (hey, that rhymes!) in the main photograph. They simply says what it is and not to look directly into the LED. We they were unnecessary and therefore we haven't shown them on the diagram above. **SC**

The final assembly of the lamp: it's a pretty tight fit inside the fuseholder but it does all go in. Just be careful that any exposed leads are insulated with heatshrink or spaghetti before sliding it in.

SERVICEMAN'S LOG

Do some sets really "self-destruct?"

A TV set, described as "self-destructing", presented itself this month and was a mystery in its own right. But it also posed another question – how long should one persist in chasing a problem, long after there is any hope of financial reward?

So what is this so-called "self-destructing" TV set? I had heard about this phenomenon from several different sources but I had never actually come across one until now.

As it turned out, the term "self-destructing" is a gross exaggeration and is much too dramatic – "intermittent failure of a number of power supply components" is a much more accurate description of the fault.

Anyway, this particular problem applies mostly to the NEC FS-6831S series employing PWC-3517 chassis. These are generally very reliable TV sets but several rental companies have complained of a few sets arriving in the workshop dead, with the power supply "destroyed", along with IC601 (STR41090) and up to about 10 surrounding components. All the parts are replaced and the set works again for another month or so before it fails again – mostly on start-up with the front panel power switch. Or, at least, that's the story.

Mr Spicer owned one of these sets and it had been fixed several times, by different technicians, until he became fed up and gave it away to another technician who happened to be a colleague.

Well, he was determined to fix it and, over the next six months or so, changed just about every part in the power supply. I obtained a scrapped chassis for him so that he could even replace the chopper and feedback transformers (T601 and T602) without cost. Wherever possible, he used genuine new NEC spares but in the end he lost patience with its repeated failures and offered it to me for spare parts.

Though a few technicians have complained about this particular symptom, NEC Technical Support were really unaware of the problem. This chassis has been in production for over 10 years and as previously stated, has been very reliable.

Bath time

I decided I would give it a go and treat it with great respect. Firstly, I noticed it was a pretty grubby chassis with lots of dust and grime on it, so I decided to give it a bath! No kidding! The secret to washing a chassis is being quick and allowing it a very long time to dry. Note, however, that mains transformers and the like should be removed first as, invariably, they will break down later if allowed to get wet.

I squirted the chassis with a commercial household cleaner and brushed the particularly dirty areas before using a high pressure fresh water spray and then very hot water. Pure water is in fact an insulator, not a conductor – but how often does one encounter pure water in real life?

I let it dry for a week, even though it looked dry enough within 24 hours, and it indeed looked very clean – like new. Any remaining grubby spots were then cleaned with more conventional PC board cleaning aerosols.

Now that it was clean, I could see that some of the electrolytic capacitors had been leaking and had badly corroded the surrounding board areas, especially around C406, C411, C501, C611 and C625. These were all replaced after giving the area a very thorough scrubbing and finally applying a fine spray of CRC 2-26.

I then soldered every faulty joint I could find on the chassis, paying special attention to areas around the power diodes before replacing all the blown components.

I noticed when checking the component values against the circuit diagram that some were not quite the same. I dug up my file on the set and discovered that, over the life of this chassis, two distinct power supplies were made available – one for the 63cm set and one for the 68cm version. This set used a 63cm picture tube and I replaced seven components that a previous technician had incorrectly substituted from the 68cm version (Q601, R417A, R602, R603, R606, R608 and R610).

I also applied some of the modifications that have been recommended over the years, especially changing C603 and C604 across the bridge rectifier from 220pF to 4700pF. I also fitted a new insulating wafer for IC601.

I didn't attribute any significance to a failure when using the front panel switch, as this controls the CPU (IC1001) and the 19V/15V supply transistors (Q652), both of which were totally isolated from the power supply. The remote control also operates the CPU IC.

When all was ready, I reassembled the chassis and fitted it into the cabi-

Items Covered This Month

- Akai CT-2868AT
- NEC FS-6831S
- Sharp CX-51E3
- NEC Cromavision FS-6807S
- Mitsubishi DNA CT 29AX1(A)
- Philips 25GR6771 G111S chassis

THE SECRET IN WASHING A CHASSIS IS BEING *QUICK...*

net. I gingerly switched on and everything worked properly. I checked the main power rails, noting that the HT was slightly low at 113.7V at TP91. However, the picture size and blooming were steady with variations of beam current and everything was working properly.

It is now a month down the track and the set is still switching on and off OK and running fine.

If I am right, I would attribute the problem to previous technicians not replacing all the leaky capacitors and failing to clean away the leaked electrolyte. In addition, a previous technician had used incorrect components in this particular set and there were also possible faulty solder joints.

Persistence doesn't pay

As I hinted earlier, this story poses the question as to why we sometimes persist with a problem, long after it has become commercially non-viable. In this case, my colleague hung on to the set for about six months and I lost count of how much time I spent on it. Granted, this was spare time (short periods between other jobs, etc) which would otherwise be wasted but how does one justify it anyway?

The simple answer is "plain stubbornness". But there is more to it than that. The solution to the problem has a real value and is not just a cause of satisfaction.

Every solution becomes another item in one's stock-in-trade; something to call upon the next time a similar fault is encountered. Every time something is learned, it makes it just that much easier to earn real money the next time around.

Not so easy after all!

I imagined that Mr Klein's Akai CT-2868AT TV set was going to be easy when he described the fault as no colour – that is, until he told me he had tried to get it fixed elsewhere and they had given up on it. Usually, most colour faults are fairly easy to fix if one is familiar with the CCIR B/G PAL D system. However, this is gradually becoming more difficult as digital techniques are being added.

Anyway, I still felt confident that I could make short work of it. However, when I switched it on and connected

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a colour bar generator to the AV input, I was amazed at the appearance of the fault which, I have to confess, is hard to describe. It was as though the chrominance reference oscillator hadn't locked but instead of different colours, the picture showed alternating bands of monochrome and colour. And at the same time, there was a large shading band (like a shadow) moving slowly from left to right – most bizarre!

I also found that the previous technician had changed the jungle section, including chroma decoder IC302, an AN5601K (the same as is used in Panasonic TV sets). He had also replaced about 10 electrolytic capacitors on the motherboard, mainly in the chroma circuits.

This was a bit of a worry, as it told me two things. One was that the previous technician was no slouch and two, he had already done most of the things I had planned to do. It didn't leave me much room to manoeuvre.

Voltage checks

I started by checking the voltage rails and all the voltages on IC302. They were all spot on, so I checked the reference oscillator and that was also spot on. I also checked all the work done by the previous technician but everything was totally correct. Yet, to produce such a dramatic effect, something had to be off – really off.

I connected a monitor to the video output socket and saw that the picture was perfect up to there. Using the CRO, I then followed the luminance and chrominance signals through Q103 (for TV reception) to IC204 LA7016 (AV/TV switch), and then on through the Teletext module CN501, pins 2 and 7 (note: the Teletext module can be removed provided a link is inserted between these pins). From there, I went to the luminance delay line where the chrominance and luminance are separated – the former goes to pin 5 of IC302, while the latter goes through Q306 to pins 15 & 16.

I thought I could detect a slight imperfection of the chroma input on pin 5 and spent a long time investigating this, especially as it seemed to come from the base of the luminance transistor Q306. I tried replacing C312 but in the end I had no explanation and assumed it was a red herring. What I did find was distortion on pin 2 (reference oscillator) and on the chrominance output to the delay line (pin 7) and onwards to the CRT.

By now I had almost exhausted all my ideas. The fault seemed to involve two different areas: the alternate couple of lines going black (horizontal frequency) and then the slow moving shadow across the screen (vertical frequency). These could be due to some distortion in the horizontal and vertical pulses but these all where correct on the oscilloscope. The 12V and 5V rails (pins 29 and 10 respectively) had no ripple on them.

In the end, I decided I needed to scope every pin of IC302 and see if anything significant would show up. Fortunately, I only reached pin 3, which is the chrominance level control from pin 37 of the microprocessor, before finding a real clue – this pin should have only a pure DC voltage present but there were all sorts of other signals present as well

A check with the multimeter showed that a DC voltage was present but that it varied with the colour control. It was now obvious that decoupling capacitor C317 (2.2µF) was leaky and replacing it fixed everything.

I left it on test for a week before Mr Klein picked it up. However, just as I was demonstrating it, I suddenly noticed a minor new fault symptom on the screen. It was giving an effect like flagwaving at the very top. Even though I noticed it, Mr Klein didn't, and it was just too late to do anything about it – so out it went.

I am now waiting by the phone, biting my nails, waiting for the recall!

Dead Sharp

Mr Tanundra's Sharp CX-51E3 TV set (H Chassis) was dead and I was immensely pleased that he had brought it into the workshop instead of trying to get me to fix it in his house.

I don't have a service manual for this model but I do have one for the CX51B2 which is a 14B chassis and not all that different – or so I thought.

Although the set was reported as "dead", it wasn't really totally dead – just no sound or picture. For starters, there was 115V on TP702 and to the line output transistor Q602 which was good. There was also voltage on the collector of the horizontal driver transistor (Q601) but it was a bit high at about 60V.

The oscilloscope showed that the line drive was present from pin 37 of the jungle IC (801, TDA8362) all the way to the horizontal output transformer (T602). However, its frequency was far too high. Consequently, the EHT was down to about 15kV. When I turned up the screen control, there was just a horizontal line, indicating no vertical timebase either.

I checked the voltage to IC801 pin 10 and found it was low but it was the horizontal and vertical oscillators I was most concerned about. There was only a small amount of signal on the 8MHz crystal (X802) on pin 35 and the voltage on it was almost non-existent, especially on pin 36.

I followed this back, expecting 9V to appear via D633 and R672 but there was none. I thought D623, an 8.2V zener, might be faulty but it was fine. The 9V rail was missing completely.

On the circuit I was using (14B), the 9V is delivered via Q604 and D733. However, in the H chassis, there is no Q604 but instead there is IC602, a 7809 3-terminal regulator. And there was voltage going in to this device but none coming out.

Fitting a new regulator fixed the problem completely, though I am surprised at how hot it ran. I have soak tested the set for a week and Mr Tanundra is happy.

A crook NEC

Mrs Richardson had arranged for her husband to deliver their 1999 NEC Cromavision FS-6807S TV set to the workshop with the complaint that there was no picture.

Because it is such a recent model, I didn't have a circuit for it and I told him that I would have to order it. His response was that he was under some pressure to get it fixed as quickly as possible although he didn't say who from.

Well, I duly put the order in straight away but in the meantime, I thought that I would take a quick squiz at it. The fault turned out to be a black raster, no screen display and no sound.

The chassis was a Thai built PWC-2477 which I removed to check for faulty joints. Well, as luck would have it, there were a couple of enormous cracks in the solder around the connections to IC501 and IC502, both 9V 3-terminal regulators.

This is just the sort of break a technician needs, being so much easier than the complex microprocessor and/or signal problems I had been was envisaging. Indeed, it was exactly what the doctor ordered and repairing the cracks fixed the problem

Mrs Richardson was delighted to have her set fixed so quickly.

A couple of house calls

It was a fairly quiet Thursday in what had been a quiet week and so when I received two requests for house calls just outside my service area, I reluctantly agreed – mostly because they were close to each other.

The first was Mrs Mason's 1996 (1994) Mitsubishi DIVA TV set, CT 29AX1(A) (A1 chassis), which she complained had a "green picture". This sounded relatively easy to fix and was probably a faulty joint on the CRT socket.

However, when I arrived, I found the 68cm set to be in a tight, dark entertainment centre connected to all sorts of accessories. What's more, the fault was actually a small dark green raster and there was no sound. To cap it all off, there were two totally undisciplined, yapping dogs running around the room, determined to trip me. It was going to be one of those days!

I stupidly thought there might be something simple I could do and, anyway, I had to look as though I had done something – even though I suspected that this was going to be an expensive workshop job.

I hadn't worked on one of these sets before and it was one with all the bells and whistles, including a wretched motorised swivel base to turn the set with the remote control. I couldn't help feeling that the user would only ever be likely to use this control once but now it was giving me a real headache. After I had managed to pull the set out far enough to unplug a bunch of AV leads, turn the set around and undo umpteen screws, in the dark, I was beginning to lose it. Trouble was the back was jammed at the bottom by the swivel base and the whole set was precariously balancing on the edge of the pull-out swivel platform of the entertainment centre.

Finally, when I lifted it off, I was presented with a large flat chassis with no access under the PC board. Also, I couldn't work out how to remove it from the case. The plastic frame looked as though it had some sort of catch system on either side near the tube but nothing I could do would free the front control panels which were wedged under the tube. So I tried to regain some self-composure by doing some meter measurements from on top of the chassis.

I was trying to identify the main HT rail from the component side of a complex set I had never seen before. And in any case, I had absolutely no idea of the voltage to expect on this rail, even if I did identify it. I looked for large high voltage rating electros and any diodes nearby which might indicate a chopper transformer but even when I thought I could identify it, there was absolutely no access. Similarly with the horizontal output transistor, which I nearly blew up.

Mrs Mason had been watching my activities closely and every so often had been making useful comments – such as, "there's not much in them these days" and also "I would have thought it would have lasted a lot longer considering how much it cost" (about $2000 four years ago).

I kept thinking, "why didn't you buy a sewing machine instead" but bit my lip and stuck to bland mutterings along the lines of "isn't the weather good?" and "the cricket is fantastic".

In the end, I gave an Oscar-winning performance of measuring the resist-

ance of one piece of screening metal to another to convince Mrs Mason that I knew something, before pronouncing that the power supply was faulty and that the set definitely had to go to the workshop – where it should have gone an hour beforehand!

She wanted a cast iron quote and an ETA for the return of the set. I was past caring at this point and plucked a figure of $300 and three weeks out of the air. Darkly she said "just wait a minute while I phone my husband".

Surprisingly, five minutes later, she reappeared, smiled, and said that would be OK. Oh well, "them's the breaks", I suppose.

The next drama I had was getting it downstairs and past the dogs and into the car – without letting the dogs out. The car was now full and I still had the other TV set to fix. I prayed I could do something with this in the home, because I couldn't take two back to the shop.

This set was a 1990 Philips 25GR-6771, G111S chassis, that was dead. It had had a line across the screen before it died.

I arrived to find the set was situated on the second floor of Mr Paton's home which had a small rickety spiral staircase. I knew that this set wasn't going to leave the house that day and started the conversation with "....and how old is this set?" "Eleven years old, eh? Well, you have had a good run out of it . . . but it is probably past its 'use-by' date. Have you thought about getting a new one?"

In the event, the "power" problem turned out to be a faulty on/off switch which I didn't have with me, so I shorted one side of the switch and told them to use the remote control or the wall socket switch to turn it on and off. The white line across the screen was due to a faulty joint around the pins of the vertical deflection socket, which connects to the vertical deflection yoke. I pointed out that this was a temporary repair that would do until they bought a new set. Mr Paton was quite happy about this and I drove off back to the workshop.

Back at the ranch

I ordered a service manual for the Mitsubishi before examining it more carefully in more congenial surroundings. The reason the chassis wouldn't come out was because of two screws in the front panel holding it in. I removed it completely and used an air compressor to blow the dust out. I then removed the PC boards from the plastic frame to get a good look at them.

When I removed the power deflection board, I could see that the whole thing had faulty joints everywhere. I spent several hours resoldering everything on all boards before reassembling them.

Eventually, I managed to get it all back together and switched the set back on. Amazingly, it all worked perfectly, so I set about retuning the stations and setting up the various menus. And the picture was truly excellent.

I found and checked the main power rail at test point TP91A. It checked out at 130V, so I replaced the back and put the set aside to soak test for a week.

In the meantime, a few days later, I received a call from Mr Paton that I didn't really need. He said that the set was dead again and it was making a burning smell just like when I was there. What smell? There had been no burning smell, save possibly the soldering iron. Reluctantly, I said I would call back but that I couldn't until I could deliver the other TV set, as they were both in the same district.

A few days later, I manoeuvred the Mitsubishi past the Mason's dogs and back into the entertainment centre. Apart from retuning the VCR, DVD and Foxtel, it was plain sailing. And Mrs Mason was happy that it cost less than I had quoted.

Mr Paton's set, on the other hand, I had to treat very carefully in case I had a fire on my hands. Gingerly, I removed the back and put it into a position where I could see what was going on when I reconnected the power. However, it was all an anticlimax; the set came on perfectly without any bother.

I checked for bad connections and any sign of smouldering but just couldn't fault it. I put it back together again and it still switched on and off perfectly via the wall switch!

Mr Paton's credibility had suddenly taken a huge dive – so much for it being dead and burning! If it breaks down again, he can (1) buy a new set (2), take it elsewhere, or (3) bring it into the workshop himself. **SC**

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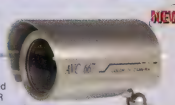

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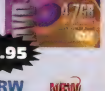

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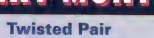

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Table Top Universal Remote Control

This tabletop universal remote control is pre-programmed with all widely used codes and is fully programmable as well. Use it to command your TV, VCR, SAT, AMP, CD, LD, DVD, tuner, cable box, etc all at once. Unit includes 2 x AA Ni-MH batteries and features an LCD display with EL backlight with matching illuminated buttons to help navigating in the dark. Size 167(L) x 180(W) x 50(H)mm. Battery charger included. See cat page 183 for details.
Cat. AR-1715
WAS $399

$349

SAVE $50

Learning Remote Control

This infrared remote control features a backlit LCD display and can be programmed with 47 different codes from up to 10 separate devices. See catalogue page 229 for details.
Cat. AR-1708
Was $129

SAVE $30

$99

Professional Dynamic Microphone Headset SELLOUT

This headset is truly professional. The look and the feel is superior quality. Soft cushion leatherette ear pads and headband makes this unit extremely comfortable for more sustained use. •Impedance (1kHz): 400ohm •Max power input: 100mW •Frequency response: 30-12kHz •SPL (1mW CNS): 92dB •Mic: dynamic 19mm
WAS $109.50
Cat. AA-2022 **Limited quantity**

SAVE $20

$89.50

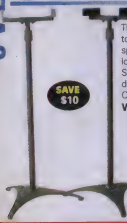
Telecommunication Headset SELLOUT

This dynamic microphone headset offers quality at an affordable price. They are used extensively in DJ work, radio stations, recording studios, talkback systems and headset telephone systems.
•Impedance (1kHz): 32 ohm •Max power input: 100mW •Frequency response: 40-12kHz •SPL (1mW CNS): 92dB •Mic: dynamic 19mm 200Ω
WAS $59.95
Cat. AA-2020 **Limited quantity**

SAVE $10

$49.95

Speaker Stands



These stands allow you to position your rear surround speakers in almost any location around the room. See catalogue page 223 for details.
Cat. CW-2850
WAS $79.95pr

SAVE $10

Now $69.95 pair

JC25 Speakers

LAST CHANCE!!! 2 WAY BOOKSHELF SPEAKER KIT

We are running just one more batch of these bookshelf speakers so now is your last chance get your hands on a set.
The speaker kit contains 5" Re/Sponse woofers & Vifa 19" D19 tweeters, pre built crossovers with rear terminals, ports, innerbond and mounting hardware internal cabling, and the pre built cabinets (with speaker holes already cut out) are made from MDF and finished in stylish black grey oak look vinyl.
•The speaker kit CS-2585 $179
•The cabinet kit CS-2586 $219

BUY TOGETHER **$375**

SAVE $23

Isobaric Subwoofer Kit

This home subwoofer kit utilises 2 polycone woofers in a compound isobaric setup.
The beauty of this design is that you get the deep bass quality of a vented subwoofer with the clean tonal accuracy of a sealed subwoofer.

The kit consists of:
•80WRMS @ 4Ω amp module AA-0503 $209
•Knockdown Isobaric enclosure CS-2536 $249
•2 x 12" polypropylene woofers CW-2130 $99ea

These items alone would cost you $656
But for this month only, pick them up for $559
That's a huge saving of $97
Cat. QM-1593

SAVE $97

THIS MONTH **$559**

Digital Sound Level Meter

Used for industrial noise level testing, HI-FI speaker measurement ... or any other situation where you need to know the level of sound or noise up to a maximum of 130dB. Features A & C weighting, fast & slow time weighting and min/max recording. For more specs see 2001 cat page 36.
WAS $189.50
Cat. QM-1590

SAVE $40

$149.50

Universal Speaker Bracket

These strong ABS plastic brackets allow multi angle mounting for speakers up to 7.5 kg in weight. Supplied with mounting hardware. See cat page 223 for specs.
WAS $24.95
Cat. CW-2804

SAVE $5

$19.95pr

Adjustable Wall Speaker Bracket

These brackets can be adjusted in 3 different ways.
•Max weight capacity: 15kg.
•Speaker depth:165 to 300mm.

WAS$34.95
Cat. CW-2840

SAVE $5

$29.95pr

B+W CCD Camera with IR Illumination /Power Supply & Lead

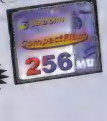
NEW

Use your existing television set as a video surveillance monitor. The camera features infrared LEDs for illuminating low light levels and also includes audio. Use it to identify people at your front door, keeping an eye on your car, garage, garden shed or any area that demands surveillance. The camera is weatherproof, Everything is included with the system - 20mtrs of cable, camera & swivel wall-mount bracket, mains adaptor plus hardware and wall plugs for camera and cable mounting (RCA and SCART plugs included and pre-wired). CCD 20 metre lead available separately Cat QC-3456 $19.95.
Cat. QC-3455

$119.95

256MB Compact Flash Memory Card

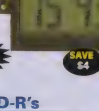
NEW



NEW LARGER CAPACITY
Rewritable non volatile digital storage for use with digital cameras, MP3 players etc.
Cat. XC-4778

$332

LCD Clock Module



This handy LCD clock module is perfect for panel mounting and features day & date functions as well as time. Requires 1 x button cell. Measures 49(h) x 87(w) x 12(d).
WAS $17.95
Cat. XC-0123

$13.95

SAVE $4

Rydata 80min CD-R's

NEW

NEW LOW PRICE
Pack of 50
80 minute CD-R's for only 70¢ each!!
Supplied in storage tub.

SAVE $5

WAS$39.95
Cat. XC-4718

$34.95

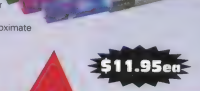
Ultraviolet LED Pen

NEW

This great new pen features an U.V illuminated barrel. Great gift idea. Batteries included.
Cat. ST-3063

$14.95

LED Illuminated Whistles



Ravers & niteclubbers will relate to these – but have you ever seen an ILLUMINATED whistle! The translucent section of the whistle glows with an enchanting light and can be selected to flash at the press of a button. Chrome barrel & clear whistle 89mm length x 10mm diameter & supplied with an approximate 44cm ball lanyard chain.
Red Cat. ST-3093
Green Cat. ST-3094
Blue Cat. ST-3095

$11.95ea

Power Jump Skipping Rope

NEW

Keep track on your fitness with this Hi-Tech skipping rope. Electronics in the handle calculates energy consumption and number of jumps per session; it even has a timer alarm from 1 to 60 minutes and can also be calibrated to a persons weight for a more accurate exercise regimen. The tough PVC rope is 3 mt long and is adjustable.
Cat. YS-5550

$24.95

LED Diving Light

A diving lamp waterproof down to 30 meters, but you can use it in any environment.Super bright with 2 illumination levels by illuminating either 4 or 8 LED's at one time. The light is adjustable up and down and is mounted on a robust rubber head strap. 4 AA batteries included.
Cat. ST-3074

$69.95

Head Torch

This tool is perfect for shedding light on whatever you need whilst leaving both hands free to work with.
Cat. ST-3052
WAS $9.95

SAVE $2

NOW **$7.95**

Phone / Fax / Modem Extension System

NEW

This " Easy Jack" phone extension product turns any power point in your home or office into an extra phone line extension.
Works with standard wired phones, c/-less phones, answering machines and even PC modems.
There's no wiring, no drilling – just plug it into any mains outlet to create an instant phone line extension. Cat. YT-7020

Don't pay $238 elsewhere!

$219

Super Bright LED Keyring Torches

NEW

These little gadgets are so good that everyone in the office bought one! They use a high brightness LED and draws very little power, but produces an amazing amount of light for their size.

Cat. ST-3043 **UV**	**$14.95**	Cat. ST-3044 **Red**	**$9.95**
Cat. ST-3046 **Yellow**	**$9.95**	Cat. ST-3047 **Blue**	**$14.95**
Cat. ST-3048 **White**	**$14.95**	Cat. ST-3049 **Green**	**$14.95**

OVERNIGHT DELIVERY AVAILABLE

FREECALL FOR ORDERS 1800 022 888

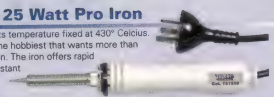
Programmable LCD Display Soldering Station

Designed in Germany NEW

We have seen a lot of soldering stations over the years and this is one of the best! Temperature is precisely controlled and can be set in increments of 1°C across the range of 150°C to 450°C. Up to 3 preset temperatures can be programmed into the control unit and instantly selected from the front panel push button. Each temperature preset is shown on the LCD control panel as well as the current tip temperature.
Cat. TS-1400
WAS $249 SAVE $50 **$199**

Jaycar 25 Watt Pro Iron

This iron has its temperature fixed at 430° Celcius. It is ideal for the hobbiest that wants more than just a basic iron. The iron offers rapid heat up and instant recovery for fast working.
WAS $34.95 Cat. TS-1550
SAVE $5 **$29.95**



Mini Laboratory Magnifier Lamp

This compact magnifying lamp features a 12watt circular fluorescent illuminating a 90mm lens. Magnification is 3 dioptres and a hinged flap protects the lens from dust when not in use. Powered by 240vac.
•Spare tube available QM-3521 for $9.95.
WAS $79.95
Cat. QM-3520
SAVE $15 **$64.95**

Desk Mount Magnifier Lamp

This is a high quality, all metal frame construction magnifier lamp featuring a 22-watt fluoro built into the 3-dioptre magnifier head.
The arm assembly has a reach of 990mm and the base slots into the bench-mounted receptacle, that screw mounts onto the side of any desk (up to 45mm thick). A great tool to assist PCB assembly/ inspection, jewellers, stamp/coin dealers or even for reading books. 240VAC powered.
•Spare tube available QM-3523 for $13.95.
WAS $119
Cat. QM-3525
SAVE $20 **$99**

200 Gram Solder Reels New Low Price

0.71mm 60% Tin 40% Lead
WAS $8.45
Cat. NS-3005
SAVE $1.50

1.0mm 60% Tin 40% Lead
WAS $8.15
Cat. NS-3010
SAVE $1.20

$6.95ea

Heatsink Compound 150 Gram

This tube of heat transfer compound will do up to 450 TO-3 package transistors, enough to last you ages. **WAS $22.95**
Cat. NM-2012
$17.95 SAVE $5

Antistatic Deluxe Desolderer

SAVE $10 **$19.95**

If you de-solder a lot, and want the best sucker available, then try this unit. Its suction power is immense; the vacuum chamber is twice the size as regular models. Tip supplied is antistatic for delicate work. Spare tip TH-1863 $7.05.
WAS $29.95 Cat. TH-1865

Deluxe Soldering Iron Stand and Solder Holder

Keep your bench tidy with this soldering stand, solder holder and sponge all in one.
WAS $26.95
Cat. TS-1505
SAVE $7.00 **$19.95**

Liquid Electrical Tape (Rubber Wrap)

This stuff is a must have for the hobbyist or electrician. Simply brush on to insulate and seal out moisture from cables, connections, PCB mount components, etc. Acid and salt resistant and wont crack or peel.
Supplied in 118mL can with brush. See catalogue page 86 for details.
Black Cat. NM-2832 Red Cat. NM-2834
Was $27.95 SAVE $5 **$22.95**

Breadboard

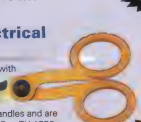
This combination breadboard features: 1660 tie points, 400 distribution holes and 1260 terminal holes. Mounted on a metal plate with 3 banana terminals and rubber feet.
WAS$40.95
Cat: PB-8816
SAVE $8 **$32.95**

Breadboard Jumper Kit

70 pieces
Cat. PB-8850
$8.95

High Quality 5.5" Electrical Shears with Pouch

These shears offer impressive cutting ability with finely honed and serrated blades.
Great for cutting insulation, heatshrink, spaghetti and light hook-up wire. The shears feature insulated handles and are supplied with a heavy duty nylon belt pouch. Cat. TH-1756
$27.95

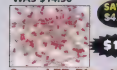


OVERNIGHT DELIVERY AVAILABLE

FREECALL FOR ORDERS 1800 022 888

Stock up with these LED Bargains

5mm Red LED Pack
Cat. ZD-1690 - Pkt 100
WAS $14.50
SAVE $4.50
$10



Assorted LED Pack
20 x 5mm red
20 x 5mm green
40 x 3mm yellow
20 x mixed
(green, yellow & orange)
Cat. ZD-1694 - Pkt 100
WAS $22.50
SAVE $7.50
$15

3mm LED Blue 1000mCd
Cat. ZD-1751
WAS $4.45
$2.95 SAVE $1.50

5mm LED White 1500mCd
Cat. ZD-1786
WAS $4.45
$2.95 SAVE $1.50

Save on 5mm Super Bright LEDS

See cat. page 283 for specifications.

4000mCd BLUE
Cat. ZD-1781

6000mCd WHITE
Cat. ZD-1780

5000mCd GREEN
Cat. ZD-1779

Were $7.80 Save $1.85 NOW $5.95ea 10+ $5.50ea
10 UP PRICES CAN INCLUDE MIXED COLOURS

6500mcd RED
Cat. ZD-1777
WAS $2.10 SAVE $0.50
NOW $1.60ea
10+ $1ea

5000mcd YELLOW
Cat. ZD-1778
WAS $1.25 SAVE $0.25
NOW $1ea
10+ $0.75ea

IP 68 Waterproof Cable Glands

These unique cable clamps incorporate a sealing mechanism that works like the iris on a camera. Simply mount the clamp, insert the cable through and tighten up, use them for speaker boxes or wherever you need an air/water tight seal. Bulk prices available.

3-6.5mm Dia Cable
Hole cutout 11.8mm
Overall length 30mm
Cat. HP-0720
Pkt 2 **$4.50**

4-8mm Dia Cable
Hole cutout 14.8mm
Overall length 35mm
Cat. HP-0724
Pkt 2 **$4.75**

5-10mm Dia Cable
Hole cut-out 18.4mm
Overall length 35mm
Cat. HP-0727
Pkt 2 **$4.95**

6-12mm Dia Cable
Hole cutout 20mm
Overall length 37.5mm
Cat. HP-0732
Pkt 2 **$5.20**

10-14mm Dia Cable
Hole cut-out 22.4mm
Overall length 40mm
Cat. HP-0736
Pkt 2 **$5.50**

13-18mm Dia Cable
Hole cutout 28mm
Overall length 46mm
Cat. HP-0740
Pkt 2 **$5.95**

ABS Plastic Rack Mount Cases

NEW

Strong ABS plastic and supplied in a knock-down form that can be assembled in seconds with just a screwdriver. Slots are moulded into the top and bottom covers to provide good cross-flow ventilation while moulded PCB standoffs allow printed circuit boards to be mounted directly onto the covers. The cases are a practical alternative to the traditional heavy metal cases and are much lighter when mounting in racks and easier to machine when fitting connectors, controls or panel meters etc. Various sizes are available i.e. 1 unit (44mm), 2 unit (88mm) or 3 unit (32mm). All sizes are 200mm deep.

1 Unit 44mm	Beige	Cat HB-5135	**$49.95**
2 Unit 88mm	Beige	Cat HB-5145	**$59.95**
3 Unit 132mm	Beige	Cat HB-5160	**$69.95**
1 Unit 44mm	Black	Cat HB-5140	**$49.95**
2 Unit 88mm	Black	Cat HB-5150	**$59.95**
3 Unit 132mm	Black	Cat HB-5155	**$69.95**

Economy Attache Case

Silver appearance and supplied with a tool pallet that sits in the lid to hold an assortment of tools (and can be removed if not needed).
•Padded •Can be locked for security 2 keys supplied.
•450W x 320H x 145D

SAVE $10
$49.95
Cat. HB6352

Aluminium Case With Foam Inserts

This case has a foam insert which has been perforated into 15mm squares. Simply remove the squares to form a custom hole which is perfect for storing and transporting sensitive instruments such as camcorders. Case measures 450W x 320H x 145D(mm). See catalogue page 251 for details.
Cat. HB-6356
WAS $69.95
SAVE $10
$59.95

TECHSTORE SPECIALS

LIMITED STOCKS ONLY. AVAILABLE FROM MAIL ORDERS ONLY - SEE DETAILS BELOW.

Powersaver Inverters.

We have a limited quantity of ex-repaired inverters from our 2000 catalogue. Now is the time to make serious savings. All units have a 3-month warranty

200W 12 to 230V
WAS $149.50
Cat. MI-5032
$69 SAVE $80.50
***53 available**

200W 24 to 230V
WAS $149.50
Cat. MI-5033
$69 SAVE $80.50
*11 available

350W 12 to 230V
WAS $199.50
Cat. MI-5035
$99.50 SAVE $100
*23 available

550W 12 to 230V
WAS $299.50
Cat. MI-5040
$149.50 SAVE $150
*16 available

920W 12 to 230V
WAS $549
Cat. MI-5045
*9 available
$299 SAVE $250

750W Sinewave 12 to 230V
WAS $ 799
Cat. MI-5055
*7 available
$499 SAVE $350

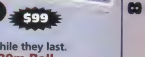
350W Sinewave12 to 230V
WAS $399
Cat. MI-5050
*26 available
$299 SAVE $170

Security/Cable Specials

Wireless B+W CCD Camera Systems
RF wireless camera systems complete with power supplies and are ex repair. They come with a 3 month warranty. WERE $599 Cat. QC-3445 *3 available
SAVE $300
$299

4 Sector Microcontrolled Alarm
Comes complete with 1 main unit, 1 PIR, 3 reed swiches, 1 external siren, power supply, and cables. **WAS $129.50**
Cat. LA-5410 *12 available.
SAVE $79.50
$50

CCD 4 Way Camera Switcher.
Switches between cameras or you can permanently display one camera. BNC connectors for video and RCA connectors for audio.
WAS $189 Cat. QC-3480
*28 available
SAVE $90
$99



Grab these rolls of speaker cable while they last.
Heavy Duty Speaker Cable 30m Roll
240/0.20mm Cat. WB-1705 WAS $19.50 *81 Rolls available
NOW $10 SAVE $9.50
Extra Heavy Duty Fig 8 100m Roll
79/0.20mm Cat. WB-1711
WAS $187.95 *27 Rolls available
NOW $85 SAVE $102.95
N.B. this item may incur a weight surcharge on delivery.

These products are only available from Techstore & Mail Orders
Call them on 1800 022 888 or visit our website
www.jaycar.com.au

OVERNIGHT DELIVERY AVAILABLE

FREECALL FOR ORDERS 1800 022 888

RESPONSE WINS AGAIN!

In the November 2001 issue of 'Street Machine' magazine, the AA-0435 was reviewed with amps from Sony, Kenwood, JBC, Boss, Signat & JVC.

To quote Street Machine's Damon Dupriez, **"..the hands-down winner of this shootout was Jaycar's stunning AA-0435..". Damon went on to say, "...Stereo power is stunning too, showing 4 x 126WRMS @ 14.4volts, making it a solid 4db or more, louder than some of the other amps tested. I love finding true bargains in my reviews, and am proud to say that the Re/Sponse AA-0435 is certainly one of the amp deals of the century".**

$449

Cat. AA-0435

Big 4 Ohm Speaker Sale

These speakers are being run out at bargain prices so be quick before they are all gone!

8" Polycone Woofer 4Ω

SAVE $17

$65

Cat Price $82
Power handling 120wrms
Limited quantity Cat. CS-2234

10" Carbon Fibre Subwoofer 4Ω

SAVE $40

$149

Cat Price $189
Power handling 160wrms
Limited quantity Cat. CS-2244

10" Double Magnet Subwoofer Dual 4Ω Voice Coils

SAVE $20

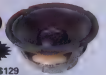
$229

Cat Price $249
Power handling 250wrms
Limited quantity Cat. CS-2226

10" Polycone Woofer 4Ω

SAVE $30

$99



Cat Price $129
Power handling 120wrms
Limited quantity Cat. CS-2236

12" Carbon Fibre Woofer 4Ω

SAVE $40

$189

Cat Price $229
Power handling 200wrms
Limited quantity Cat. CS-2246

UHF Slope Adjustable Whip

Designed to fit late model vehicles with sloping fenders and bonnets. To adjust the slope once the antenna is mounted, simply grasp the adjusting section and gently ease it into the desired position.
•Length 610mm Cat. DC-3072

$19.95

UHF 4.5dB Black Whip

Offers at least 4.5dB gain.
•Black powder coated stainless steel whip
•Length 565mm.
•Suits standard UHF 5/16" base
Cat. DC-3074

$17.95

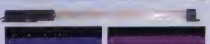
UHF Base

Constructed from UV stable polypropylene and a 5/16", 25TPI plated brass bolt.
Cat. DC-3062

$10.95

20" Colour Changing Neon Tube

Two neon's in one! This unique neon has a 3-way switch that will select between coral pink, ice blue or fade between.
WAS $64.95
Cat. ST-3138

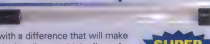


SAVE $10

$54.95

20" Neon "Lava" Lamp

This is a neon with a difference that will make all other neons look ordinary, with its flow of twisting multicoloured light that's sure to impress. Powered from 12volts via cigarette lighter plug.
WAS $83.95
Cat. ST-3140
Limited stocks



SUPER SAVING

SAVE $20

$63.95

20W 12VDC Fluoro Light

This attractive, high quality fluorescent light fitting is supplied with a standard 24 inch 20 watt tube which is protected by a clear acrylic cover. The unit has a retractable carry handle for portable use or it can be wall mounted for fixed installations. Operates from 12VDC & includes on/off switch. 95W x 75H x 680Lmm. 520mA.
WAS $59.95
Cat. ST-3060

SAVE $15

$44.95

SHADOW Car Engine Immobiliser

This engine immobiliser is made to and has passed the latest 2001 Australian and New Zealand standards for vehicle immobilisers (AS/NZS 4601:1999). The unit features code hopping remotes twin relay circuits for immobilisation, auto arming and all black wiring to make life hard for any would be thief. For all the features see page 181 in the 2001 cat.
Cat. LA-8970

$129.50

SHADOW Car Alarm Upgrade Kit

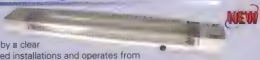
This pack will upgrade your Shadow Immobiliser to a full alarm system with backup battery siren, shock sensor and bonnet switch. If you buy the Shadow immobiliser this month you can buy the upgrade kit for only
Was $79.50
Cat. LA-8975

SAVE $30

$49.50

40W 12VDC Fluoro Light

Attractive, high quality fluorescent light fitting includes 2 standard 24 inch 20 watt tubes, protected by a clear acrylic cover. Designed for fixed installations and operates from 12VDC. Size is 140 (W) x 75 (H) x 830 (L)mm. 1 tube 490mA - 2 tubes 980mA.
Was $79.95
Cat. ST-3062



NEW

SAVE $20

$59.95

OVERNIGHT DELIVERY AVAILABLE

FREECALL FOR ORDERS 1800 022 888

OVERNIGHT DELIVERY AVAILABLE

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12 Volt Intelligent Charger

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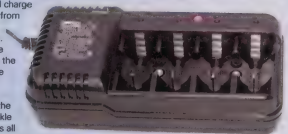

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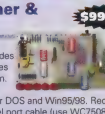

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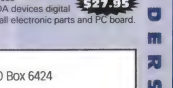

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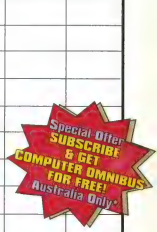

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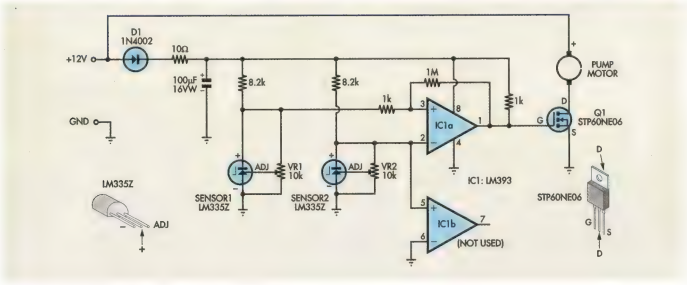
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Pump controller for solar hot water system

This circuit optimises the operation of a solar hot water system. When the water in the solar collector is hotter than the storage tank, the pump runs.

The circuit comprises two LM335Z temperature sensors, a comparator and Mosfet. Sensor 1 connects to the solar collector panel while Sensor 2 connects to the hot water panel. Each sensor includes a trimpot to allow adjustment of the output level. In practice, VR1 and VR2 are adjusted so that both Sensor 1 and Sensor 2 have the same output voltage when they are at the same temperature.

The Sensor outputs are monitored using comparator IC1. When Sensor 1 produces a higher voltage than Sensor 2, which means that sensor 1 is at a higher temperature, pin 1 of IC1 goes high and drives the gate of Mosfet Q1. This in turn drives the pump motor.

IC1 includes hysteresis so that the output does not oscillate when both sensors are producing a similar voltage. Hysteresis comprises the 1MΩ feedback resistor between output pin 1 and non-inverting input pin 3 and the input 1kΩ resistor. This provides a nominal 12mV hysteresis so that voltage at Sensor 1 or Sensor 2 must differ by 12mV for changes in the comparator output to occur. Since the outputs of Sensor 1 and Sensor 2 change by about 10mV/°C, we could say that there is a degree of hysteresis in the comparator.

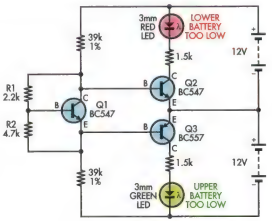
Note that IC1 is a dual comparator with the second unit unused. Its inputs are tied to ground and pin 2 of IC1 respectively. This sets the pin 7 output high. Since the output is an open collector, it will be at a high impedance.

Mosfet Q1 is rated at 60A and 60V and is suitable for driving inductive loads due to its avalanche suppression capability. This clamps any inductively induced voltages exceeding the voltage rating of the Mosfet.

The sensors are adjusted initially with both measuring the same temperature. This can be done at room temperature; adjust the trimpots so that the voltage between ground and the positive terminal reads the same for both sensors. If you wish, the sensors can be set to 10mV/°C change with the output referred to the Kelvin

Battery equality monitor

Almost all 24V power systems in trucks, 4WDs, RVs, boats, etc, employ two series-connected 12V lead-acid batteries. The charging system can only maintain the sum of the individual battery voltages. If one battery is failing, this circuit will light a LED. Hence impending battery problems can be forecast. The circuit works by detecting a voltage difference between the two series connected 12V batteries. Idle current is low enough to allow the unit to be permanently left across the batteries.

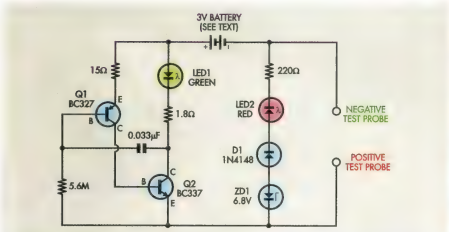


G. La Rooy, Christchurch, New Zealand. ($30)

scale which is 273K at 0°C. So at 25°C, the sensor output should be set to (273 + 25 = 298) x 10mV or 2.98V.

Note that the sensors will produce incorrect outputs if their leads are exposed to moisture and they should be protected with some neutral cure silicone sealant. The sensors can be mounted by clamping them directly to the outside surface of the solar collector and on an uninsulated section of the storage tank. The thermostat housing is usually a good position on the storage tank.

John Clarke,
SILICON CHIP.



Component & voltage tester

This simple circuit tests speakers, microphones, transformers and voltage. It's basically a very low frequency oscillator that produces extremely short 'fruity' pulses. The type of sound produced is very easy to hear and to determine the precise direction it is coming from, thus making it ideal for checking the phasing in multiple speaker installations. It is also very useful for car stereo installations as well as public address systems where it can drive dozens of speakers directly on a 100V or 70V line system.

The signal is also easy to hear on a public address system so that you can drive around a large installation with the window down and easily hear each speaker as you drive past. It is easy to check that a speaker is in phase with its neighbours, by listening for the artificial centre created between two identical sound sources.

Q1 and Q2 oscillate when connected to loads between zero and about 1000Ω. The frequency increases as the resistance of the load increases – 8Ω loads produce about 8Hz output while 100Ω loads will produce about 100Hz output, although it is only approximate.

The unit is also useful for checking dynamic microphones (not condenser types), headphones, transformers (both audio and mains) and resistance loads (only visual checks via the LED). The pulses produced can sound too loud for some delicate circuits such as dynamic microphones and headphones, but the pulse is so short that it is virtually impossible to do any damage; the average current flow is only a few milliamps.

The circuit needs no power switch as the oscillator only operates when the negative side of the battery is connected through the load being tested. The LED flashes at each pulse as a visual indication that the load is lower than about 1000Ω. The circuit works from a 3V battery pack. To use a 9V battery change the 15Ω resistor to 47Ω, the 1.8Ω resistor to 5.6Ω and the .033μF capacitor to .01μF.

LED2, diode D1, zener diode ZD1 and the series 220Ω resistor form a voltage indicator which is used to detect and indicate any voltage greater than about 10V. LED2 only illuminates if the voltage rises above the threshold set by ZD1 and D1, which is more than the battery voltage (3V or 9V). These components can be omitted if the device is not going to be used for working on cars. However, it's quite handy having a device that can check power wires, shorts to chassis and speakers in a car.

Philip Chugg,
Launceston, Tas. ($30)

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6-Channel IR Remote Volume Control

Ideal for use with Dolby 5.1-channel digital decoders, this 6-channel volume control will allow you to adjust the volume of all channels simultaneously. It also includes infrared remote control so that you can adjust the volume from your armchair.

Pt.1: By JOHN CLARKE

OK, SO YOU'VE JUST bought yourself a fancy new DVD player with inbuilt Dolby 5.1-channel decoding. A matching multi-channel amplifier would also be nice but what if your budget won't stretch that far?

For many people, the answer is quite simple – use existing hifi stereo amplifiers that they either already own or can scrounge for next to nothing. Most of us have progressively upgraded our hifi systems over the years and typically have old – but still working – stereo amplifiers stashed in a cupboard or in the garage.

For example, you can use your main hifi stereo amplifier for the two front (left and right) channels, plus a second stereo amplifier for the two rear channels. A third stereo amplifier is then used to amplify the centre and subwoofer outputs from the DVD player – see Fig.1.

By the way, you don't need integrated stereo amplifiers with preamplifier and tone control stages in this application. If you have one or more stereo power amplifiers, they will do the job just fine.

Adjusting the volume

Using existing stereo amplifiers might be economical but there is one big disadvantage – you have to adjust three separate volume controls (more if an amplifier has separate volume controls for each channel). And that's fiddly.

Wouldn't it be nice if you could adjust the volume of all six channels simultaneously using just one control? That's just what this project does and as a bonus, it throws in infrared (IR) remote control as well. A low-cost commercial IR remote provides the necessary control signals.

Basically, the SILICON CHIP 6-Channel Remote Volume Control accepts all six channels from the DVD player and provides outputs that can be uniformly varied in level with excellent tracking accuracy. These outputs are then fed into the stereo amplifiers, which have their volume controls set to fixed positions.

As shown in the photos, the unit is housed in a 1U-high rack-size metal case. It's easy to drive, with just a few controls on the front panel: an on/off switch plus three pushbuttons for volume up, volume down and mute. A LED bargraph display lets you check the current volume setting.

Another feature of the unit is its excellent performance, so that it doesn't degrade the high-quality sound from your DVD player. It has extremely low noise and distortion and also provides accurate tracking between each channel.

This means that the sound balance between the various channels is maintained regardless of the volume setting. In addition, there is virtually no coupling between channels so that the signal in one channel is not heard in another.

Specifications

The accompanying specifications panel lists the performance of the unit. In particular, the volume can be adjusted over a 76dB range, with 1dB steps from 0dB (maximum volume) through to -48dB. After that, the volume is adjusted in 2dB steps down to the -76dB attenuation level. The volume can also be Muted at any volume setting to provide an attenuation of at least -96dB.

As stated earlier, the volume can be adjusted using either the front-panel pushbutton switches or by the matching buttons on an IR remote control. These controls allow adjustment from full volume to minimum volume in about seven seconds. Alternatively, you can use the Channel Up/Down buttons on the remote control for even faster volume changes.

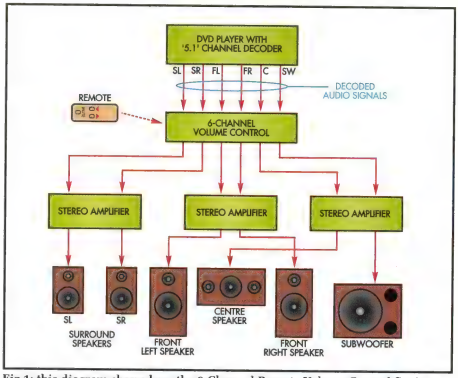


Fig.1: this diagram shows how the 6-Channel Remote Volume Control fits into a surround sound system. It accepts the Dolby decoded outputs from a DVD player and in turn drives three stereo amplifiers.

The LED bargraph display consists of 20 LEDs, each representing a 4dB volume step. "In-between" settings are indicated by lighting two adjacent LEDs, which means that the display is actually capable of 2dB resolution – ie, it can indicate 38 different volume settings from 0dB to -76dB.

Note that the LED bargraph does not indicate the 1dB volume steps that are available down to the -48dB attenuation level. These smaller 1dB changes are provided to give a fine volume adjustment, so that the exact level can be selected for this important range of the volume control. Below the -48dB level, the volume is quite "soft" and so the 2dB level steps are more than adequate.

Muting is indicated by flashing the current volume level LED (or LEDs) on the display. It is released by pressing the Mute switch again or by pressing the Up Volume switch. However, the muting remains on if the Down Volume switch is pressed.

This allows the volume to be reduced to a more comfortable level while the muting is still in effect.

SPECIFICATIONS

Total Harmonic Distortion (THD)	0.002% at 1kHz and 1V RMS (see graph)
Frequency Response	-0.1dB at 20Hz and 20kHz
Signal-to-Noise Ratio	110dB with respect to 1V RMS with 20Hz to 20kHz filter (112dB A weighted)
Separation Between Channels	80dB at 20kHz, 94dB at 1kHz and 96dB at 100Hz worst case with 1kΩ loading resistor on measured channel and 1V RMS input on other channel
Attenuation Steps	1db from 1-48dB attenuation, 2dB from 48-76dB attenuation
Volume Tracking	Typically better than ±0.7dB to -60dB, ±1.5dB >60dB attenuation
Mute Attenuation	96dB minimum
Signal Handling	4V RMS
Display Resolution	2dB steps

Parts List For 6-Channel Remote Volume Control

1 1U rack case (Altronics H-5035 or equiv.)
1 Universal remote control with Mute, Channel and Volume Up/Down buttons (Altronics A-1007, Jaycar AR-1703, DSE G-1223, etc)
1 2 x 12V 15-30VA mains transformer (Altronics M-4912 or equiv.) (T1)
1 SPST mains power switch (S4)
1 M205 mains panel-mount safety fuseholder (F1)
1 0.5A slow blow M205 fuse
1 7.5A mains lead with moulded plug including earth pin
1 mains cord grip grommet
2 M3 crimp lug eyelets
2 insulated spade connectors (female)
1 .001µF 250VAC X2 MKT polyester capacitor
1 10A 3-way mains terminal block (chassis mount)
1 piece of Elephantide insulation, 35 x 35mm
1 30mm length of 10mm-dia. heatshrink tubing
4 stick-on rubber feet
10 100mm long cable ties
4 8-way 0.1-inch pin header plugs
1 270mm length of 8-way rainbow cable
4 M3 tapped x 12mm spacers
4 M3 tapped x 10mm spacers
2 6mm untapped spacers
17 M3 x 6mm screws
3 M3 x 12mm screws
1 M3 x 10mm screw
5 M3 nuts
2 M3 star washers
6 6g x 10mm self tapping screws for RCA sockets

AUDIO ATTENUATOR BOARD

1 PC board, code 01103021, 121 x 85mm
2 8-way 0.1-inch pin headers
1 PC stake
6 PC-mount RCA sockets (Altronics P 0210)
1 600mm length of 0.7mm tinned copper wire

Semiconductors

2 LM1973N 3-channel audio attenuator (IC4,IC7)
4 TL072 dual JFET op amps (SGS Thomson or Motorola brands) (IC2,IC3,IC5,IC6)

Capacitors

2 1000µF 16VW PC electrolytic
6 10µF bipolar (non-polarised) electrolytic
4 1µF 25VW PC electrolytic
6 1µF bipolar electrolytic or MKT polyester
4 0.1µF MKT polyester

Resistors (0.25W, 1%)

6 10kΩ	6 150Ω
2 2.2kΩ	1 1.2kΩ

DISPLAY BOARD

1 PC board, code 01103022, 231 x 56mm
1 8-way 0.1-inch pin header
1 TO-220 heatsink, 19 x 19 x 10mm
3 SPDT momentary subminiature pushbutton switches (S1-S3) (Altronics S 1498)
3 7.5mm diameter caps for switches
1 M3 x 6mm screw
1 M3 nut
1 18-pin DIL IC socket
1 4MHz crystal (X1)
1 250mm length of 0.7mm tinned copper wire

Semiconductors

1 PIC16F84 microcontroller programmed with REMVOL.HEX code (IC1)
1 infrared remote control demodulator IC (IRD1)
1 7805 5V 3-terminal regulator (REG1)
6 BC328 PNP transistors (Q1-Q6)
6 1N4148, 1N914 diodes (D6-D11)
4 5-segment green LED bargraph displays (Altronics Z 0972) (LEDs1-20)
1 3mm green LED (LED22)

Capacitors

1 1000µF 16VW PC electrolytic
3 10µF 25VW PC electrolytic
1 0.1µF MKT polyester
2 18pF ceramic

Resistors (0.25W, 1%)

1 100kΩ	1 470Ω
2 10kΩ	1 220Ω
4 1kΩ	5 120Ω
4 680Ω	1 100Ω 5W

POWER SUPPLY BOARD

1 PC board, code 01103023, 71 x 45mm
1 8-way 0.1-inch pin header
4 PC stakes
1 25mm length of 0.7mm tinned copper wire

Semiconductors

1 7812 regulator (REG1)
1 7912 regulator (REG2)
1 7806 regulator (REG3)
1 7906 regulator (REG4)
5 1N4004 diodes (D1-D5)

Capacitors

2 1000µF 25VW PC electrolytic
2 470µF 16VW PC electrolytic
4 10µF 25VW PC electrolytic

Resistors

2 39Ω 0.25W 1%
1 33Ω 5W

Another feature of the unit is that it remembers the current volume level when the power is switched off. It then automatically reverts to this volume level when power is next applied. The muting is always initially off when the unit is switched on, even if the unit was muted at switch-off.

Commercial transmitter

As mentioned earlier, this unit can be operated using a commercial IR remote control, which can also be used to control other equipment (eg, a TV, VCR or satellite receiver). In fact, quite a few IR remote transmitters will work with the 6-Channel Remote Volume Control and some of these are in the parts list.

At one end of the scale, you can use a TV-only remote control unit with

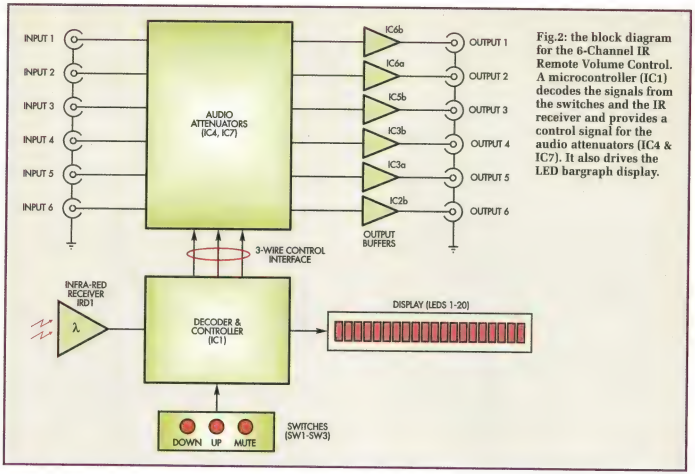


Fig.2: the block diagram for the 6-Channel IR Remote Volume Control. A microcontroller (IC1) decodes the signals from the switches and the IR receiver and provides a control signal for the audio attenuators (IC4 & IC7). It also drives the LED bargraph display.

just Volume Up/Down, Channel Up/Down, Mute and Operate controls. Alternatively, you can use a more elaborate unit which can also used to operate some of your other equipment.

The main proviso with the IR remote control is that it is able to output Philips RC5 codes. There are three possible RC5 code sets that you can use, so if you already have a Philips TV set and/or VCR, you can select an unused code to avoid controlling both devices at once.

In that case, you will need to purchase a preprogrammed IR remote control that can be set to control satellite receivers (as well as TVs and VCRs).

OK, enough of the preamble. Let's find out how it works.

Block diagram

Take a look now at Fig.2 which is the block diagram of the 6-Channel Remote Volume Control. It's really quite simple in concept, with just a few main circuit blocks (you didn't really want anything too complicated and expensive, did you?).

Here's how it works. First, the six audio signals from the DVD player are fed to an audio attenuator block. This then attenuates all six channels, according to the control signals applied via a 3-wire interface from the Infrared Decoder/Controller block (IC1).

IC1 is actually a microcontroller. Its job is to decode signal inputs from the Down, Up & Mute switches and from

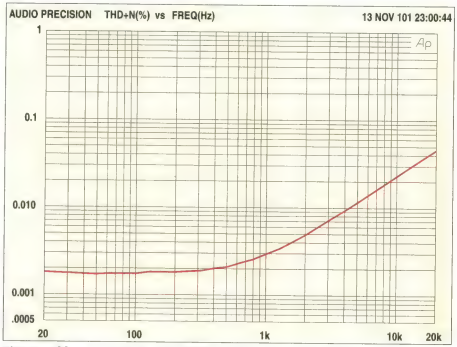


Fig.3: total harmonic distortion (THD) vs. frequency. As can be seen, the performance is excellent, with THD less than .02% up to around 10kHz.

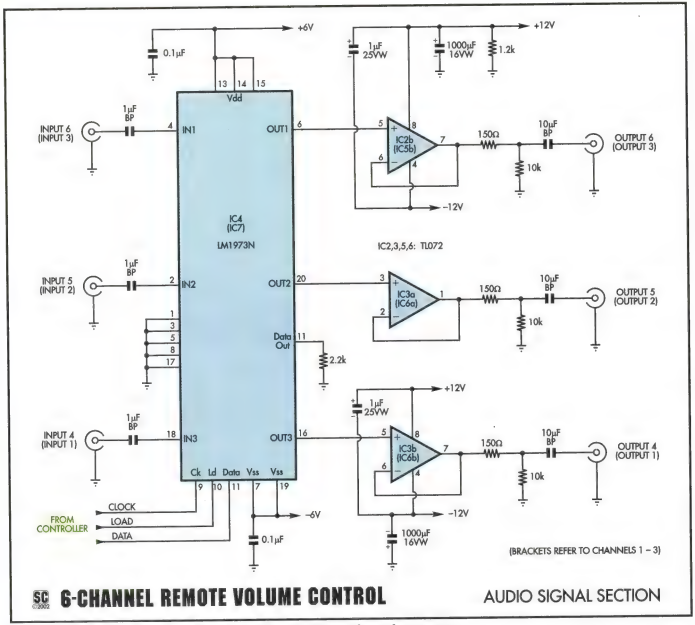


Fig.4: the audio attenuator section is based on two LM1973 3-channel attenuator ICs. The attenuation level is adjusted according to a 3-wire digital control signal on pins 9-11 and op amps IC2b, IC3a & IC3b buffer the attenuated outputs.

the infrared receiver (IRD1) which picks up signals from the remote control. It then generates the 3-wire control signals (Data, Clock & Load) which are applied to the Audio Attenuator.

In addition, the microcontroller also drives the 20-LED bargraph display.

Finally, the signals from the Audio Attenuator are buffered by op amps IC2, IC3, IC5 & IC6 and fed to the output sockets. These outputs in turn are fed to the audio amplifiers.

Circuit details

Figs.4-6 show the complete circuit details of the 6-Channel Remote Volume Control. We'll look at each of these sections in turn.

Fig.4 is the audio attenuator section. For the sake of clarity, only channels 4-6 are shown – channels 1-3 are identical except for the IC numbering which is shown in brackets.

IC4 (and IC7) are "3-Channel 76dB Audio Attenuators with Mute" (from National Semiconductor). Each channel includes a resistive array with various tappings to select the requisite amount of signal attenuation. The input impedance is a nominal 40kΩ, while the output impedance varies from 25kΩ to 35kΩ, depending on the attenuation level.

As indicated previously, the attenuation level is adjusted using a 3-wire serial digital control signal.

The audio signals from the DVD player are fed to IC4 via 1µF bipolar capacitors. These serve two purposes: they roll off the low-frequency response below 4Hz (in company with the input impedance); and they prevents any DC current flow in the resistors that make up the attenuators.

The outputs from the attenuators appear at pins 6, 20 & 16 (OUT1, OUT2 & OUT3) and are fed to JFET op amp stages IC2b, IC3a & IC3b. These op amps are wired as unity-gain buffer stages and have several functions: (1) they provide low-impedance output signals which are suitable for driving power amplifier stages; (2) their high input impedance prevents loading of

Fig.5: the control display section is based on microcontroller IC1. This processes the inputs from the switches and IR receiver and provides the 3-wire control signal for the attenuator ICs. It also drives the LED displays.

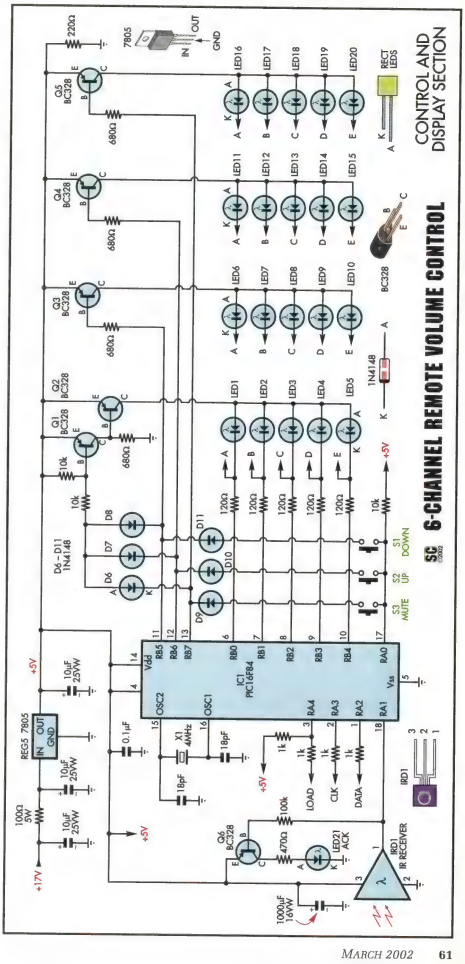
the attenuators, thus maintaining the accuracy of the volume setting; and (3) the negligible bias currents flowing in the op amp inputs prevent unwanted clicks in the audio signals as the output impedance of the attenuators changes with volume

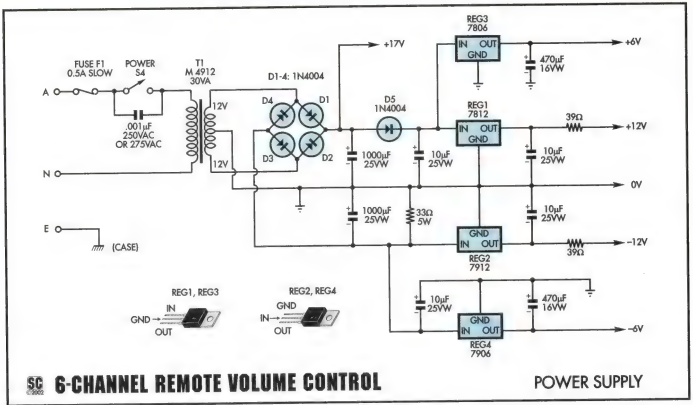
Note that the output of each op amp buffer is isolated from its output terminal using a 150Ω resistor, to prevent instability. In addition, the outputs are AC-coupled via 10µF bipolar capacitors to prevent any DC offsets from being fed through to the power amplifiers. The 10kΩ resistors tying the op amp outputs to ground are included to ensure that the outputs discharge to ground when power is removed from the circuit. This prevents switch on clicks when power is reapplied.

Note that IC2 and IC5 are actually TL072 dual op amps even though we are using only one op amp in each package. They are specified because the dual-package versions produce a lower switch-on click than TL071 single op amps. For the same reason, it is necessary to use either Motorola or SGS Thomson (ST) TL072s in preference to those from other manufacturers, as these produce the lowest output transients at switch on.

Each op amp package is powered from ±12V supply rails. These rails are decoupled at each op amp's supply pins using a 1µF capacitor, while two 1000µF 16VW capacitors provide overall decoupling of the supply. These relatively large capacitors ensure that the op amp supply rails decay away at a slow rate when power is removed from the circuit, to prevent switch-off thump.

The two audio attenuator ICs (IC4 & IC7) are powered from ±6V rails which are decoupled using 0.1µF capacitors. Their Clock, Load and Data inputs are at pins 9, 10 & 11 and these are controlled by microcontroller IC1 (see Fig.5) to set the attenuation values. Note that each of the three channels in each IC is individually addressable and could theoretically be loaded with any attenuation value.





SC 6-CHANNEL REMOTE VOLUME CONTROL

POWER SUPPLY

Fig.6: the power supply circuit uses four 3-terminal regulators to deliver ±6V and ±12V rails for the audio circuitry. The +17V rail feeds a 5V 3-terminal regulator in the display section.

In this case, however, both IC4 and IC7 have these three control lines connected in parallel. As a result, the attenuation value set for channel 6 is also set in channel 3. Similarly, channels 5 and 2 have the same attenuation value, as do channels 4 and 1. In addition, the software programmed into the microcontroller sets all channels to the same value.

Control & display circuit

This circuit section is based mainly on a PIC16F84 microcontroller (IC1) – see Fig.5. It primary function is to decode the signals from switches S1-S3 and from the infrared receiver (IRD1) and provide the 3-wire control signals to IC4 (and IC7).

It also drives the 20-LED bargraph display in multiplex fashion. This enables the LEDs to be driven via five common lines at the RB0-RB4 outputs of IC1.

The RB5-RB7 outputs and transistors Q1-Q5 select which bank of five LEDs will be driven at any one time. For example, when RB7 is low, Q5 turns on and the anodes of LEDs 16-20 are all high. As a result, any low lines at RB0-RB4 drive the corresponding LEDs in this group via series 120Ω resistors (eg, if RB0 goes low, LED16 will light).

When RB7 subsequently goes high, RB6 goes low and selects LEDs 11-15 via Q4. RB6 then goes high and RB5 goes low to select LEDs 6-10 via Q3.

When ever one of the RB5-RB7 lines is low, transistor Q1's base is pulled low via a 10kΩ resistor and an OR gate made up of diodes D6-D8. This turns Q1 on which means that Q2 is off (as are LEDs1-5).

However, when RB5-RB7 all go high, Q1 turns off and Q2 turns on (due to its 680Ω base resistor) and pulls the anodes of LEDs1-5 high. These LEDs can now be driven by the RB0-RB4 outputs of IC1, as before. So this simple gating technique allows us to drive four banks of LEDs using only three outputs (RB5-RB7) from IC1.

When ever one of the RB5-RB7 lines is low, the RA0 input is monitored to check whether a switch has been pressed. A closed switch causes the normally high RA0 input to be pulled low via either D9, D10 or D11 when an RB5-RB7 line goes low.

For example, if S1 (Volume Down) is pressed, RA0 is pulled low via D11 when RB5 goes low. Similarly, if S2 (Volume Up) is pressed, RA0 is pulled low via D10 and RB6. And if S3 (Mute) is pressed, RA0 is pulled low via D9 when RB7 goes low.

By this means, the software in IC1 detects which switch has been pressed and generates the appropriate control signals at the RA2-RA4 outputs which are then fed to IC4 & IC7

Note that the 3-wire control outputs are fed to IC4 & IC7 via 1kΩ resistors. These slow down the control signal rise times so that they don't cause noise in the audio signal. Note also that RA4 of IC1 is an open drain output and requires a pullup resistor. This output is high at power up and this ensures that the attenuators are initially set to minimum volume, after which the software quickly takes over and sets the volume to the required level.

IR control

The infrared receiver circuitry is simplicity itself and is based on infrared receiver module IRD1. This 3-lead device amplifies, filters and demodulates the coded signals picked up from the IR transmitter and feeds the demodulated signal to the RA1 input of IC1. It also drives Q6 which flashes the Acknowledge LED (LED21) each time pin 1 of IRD1 goes low.

As a result, the Acknowledge LED

flashes (to indicate that infrared signals are being picked up) each time you press a button on the transmitter.

IC1 decodes the signals applied to its RA1 input and, provided the coding is correct, changes its outputs accordingly. The default code is for the TV1 address but this can easily be changed so that you can use either the SATellite 1 (SAT1) or SATellite 2 (SAT2) code (eg, if you are already using TV1 to control your TV set).

A 4MHz crystal connected between pins 15 & 16 provides the timing for IC1. The two 18pF capacitors ensure that the crystal is correctly loaded, so that it starts reliably.

Power for the microcontroller is supplied via 5V regulator REG5. This is isolated from the incoming +17V supply using a 100Ω 5W resistor and decoupled at its input and output using 10µF electrolytic capacitors.

In case you're wondering, the 100Ω resistor causes the 5V supply to rise relatively slowly at power up, to ensure a "soft" start. It also dissipates power which would otherwise have to be dissipated by REG5 (which, in turn, would require a bigger heatsink).

In addition, a 1000µF capacitor is used to decouple the +5V supply line at IRD1. This prevents any switching noise on the +5V supply from being amplified within the infrared receiver.

The 220Ω resistor connected across the 5V supply ensures that the voltage falls to zero at switch off. This is necessary to ensure that IC1 resets correctly when power is reapplied.

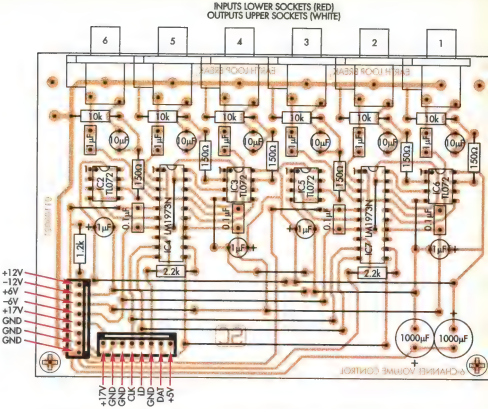


Fig.7: install the parts on the audio attenuator (signal) board as shown here, taking care to ensure that the ICs and electrolytic capacitors are correctly oriented. The bipolar capacitors can go in either way around.

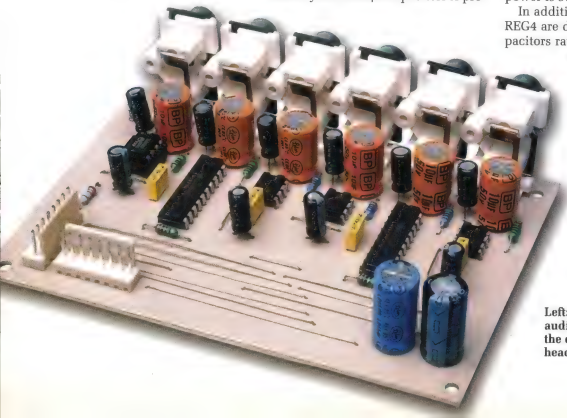
Power supply circuit

Fig.6 shows the power supply circuit. It uses a 24V centre-tapped mains transformer, the output of which is rectified using diodes D1-D4 and filtered by two 1000µF capacitors to produce nominal ±17V rails. These rails are then fed to regulators REG1-REG4 to derive ±12V and ±6V supply rails.

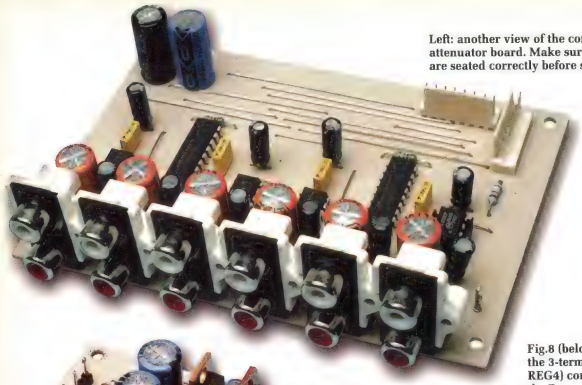
Note that REG1 and REG3 are isolated from the +17V supply using diode D5. This ensures that the regulated positive supply rails fall at the same rate as the negative rails when power is switched off.

In addition, the outputs of REG3 & REG4 are decoupled using 470µF capacitors rather than 10µF capacitors, as used at the outputs of REG1 & REG2. This ensures that the ±6V supply rails fall slower than the ±12V supply rails at switch off. And that in turn ensures that the inputs to the op amps are tied to ground via the attenuator output resistances while ever power is applied to the op amps.

The +17V rail pro-



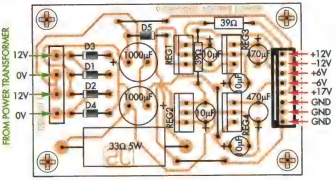
Left: this is the completed audio attenuator board. Note the orientation of the two pin header sockets.



Left: another view of the completed audio attenuator board. Make sure that the RCA sockets are seated correctly before soldering their leads.

This is the completed Power Supply Board. Mount the 5W resistor slightly proud of the board to aid cooling.

Fig.8 (below): be sure to place the 3-terminal regulators (REG1-REG4) correctly when building the Power Supply Board.



vides power to the display circuit and this load is balanced by including a 33Ω load resistor across the -17V supply. This is done to produce similar decay times for the ±17V rails at switch off.

Note that the +12V and -12V outputs from REG1 & REG2 are decoupled with 39Ω resistors before being applied to the signal circuitry. These resistors slow down the risetime for the op amp supply rails at power up.

Basically, the power supply has been designed to deliver its various supply rails without causing excessive voltage excursions in the op amp outputs during power up and power down. As a result, switch-on thumps

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	8	10kΩ	brown black orange brown	brown black black red brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	1.2kΩ	brown red red brown	brown red black brown brown
❑	4	1kΩ	brown black red brown	brown black black brown brown
❑	4	680Ω	blue grey brown brown	blue grey black black brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	220Ω	red red brown brown	red red black black brown
❑	6	150Ω	brown green brown brown	brown green black black brown
❑	5	120Ω	brown red brown brown	brown red black black brown
❑	2	39Ω	orange white black brown	orange white black gold brown

and switch-off instability problems are avoided.

Power on/off switching is provided by mains switch S4, with a 0.5A fuse protecting the transformer primary. The .001µF capacitor across S4's contacts prevents arcing at switch off, again to avoid sudden transient voltage excursions at the op amp outputs.

Construction

The unit is easy to build, with separate PC boards for each of the circuits shown in Figs.2-4. These boards are as follows: (1) an audio attenuator board coded 01103021; (2) a display board coded 01103022; and (3) a power supply board coded 01103023.

Figs.7-9 show the assembly details for the PC boards. As shown in the photo, the PC boards are interconnected using 8-way flat cables that plug into pin headers.

Signal board assembly

Begin the assembly by building the audio attenuator board – see Fig.7. Install the wire links first, then the resistors, ICs and capacitors. Make sure that the ICs and the electrolytic capacitors are all oriented correctly.

The bipolar (BP) capacitors are non-polarised and can be installed either way around. Table 1 shows the resistor colour codes but we suggest that you also check each value using a digital multimeter as some of the colours can be difficult to decipher.

The audio attenuator board can now be completed by installing the two 8-way pin headers and the RCA sockets. Note that it will be necessary to cut off the plastic locating clips at the base of each RCA socket pair before installing it. You can do this using a pair of sidecutters.

Push the RCA sockets all the way down onto the board and make sure they are properly seated before soldering their leads.

Display board assembly

Fig.9 shows the parts layout on the Control & Display board. Again, begin by installing the wire links, then install the resistors, diodes and capacitors. Note that the 100Ω 5W resistor should be mounted about 3mm proud of the PC board, to allow the air to circulate underneath it for cooling.

The six transistors (all BC338 or BC337) can go in next, followed by the 4MHz crystal (X1). That done, you can install the three pushbutton switches (S1-S3).

Next, install an 18-pin DIL socket for IC1 but don't install IC1 (the PIC microcontroller) at this stage. That step comes later.

The 7805 regulator (REG5) can go in now. This device is mounted horizontally which means that you have to bend its leads down by 90° before mounting it on the PC board.

This is best done by slipping an M3 screw through the device tab, positioning it on the board and then gripping one of the leads with a pair of needle-nose pliers just before it reaches its mounting hole. The device can then be lifted clear of the board and the lead bent down at right angles, after which the procedure can be repeated for the two remaining leads.

REG5 can now be fitted to a small mini-U heatsink and the assembly bolted to the PC board using a 6mm M3 screw, nut and star washer. Don't forget to solder its leads after bolting it down.

The 5-segment LED bargraph displays have a plastic moulding that has a raised section at one end and a recessed section at the other. This allows them to be locked together to form one continuous bargraph.

Before mounting the displays, first orient each segment so that the anode leads (the longer of the two for each LED) are towards the right. This done, bend the leads down at right angles about 5mm from the plastic body, so that the front faces of the LEDs will sit about 4mm from the edge of the PC board.

Now mount the LED segments so that they sit about 2.5mm proud of the board surface. A 2.5mm-thick "standoff" (made from a strips of cardboard, for example) will make this job easy – just sandwich the standoff between the LED segment and the PC board, solder the two outer leads, then remove the standoff and solder the remaining leads.

LED21 is mounted similarly by bending its leads at right angles and

Table 2: Capacitor Codes

	Value	IEC Code	EIA Code
❑	1µF	105	1u
❑	0.1µF	104	100n
❑	0.001µF	102	1n
❑	18pF	18	18p

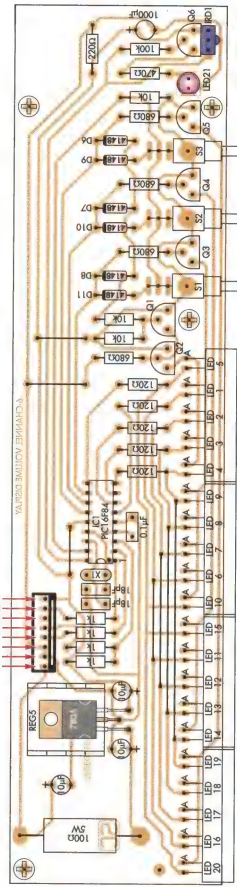
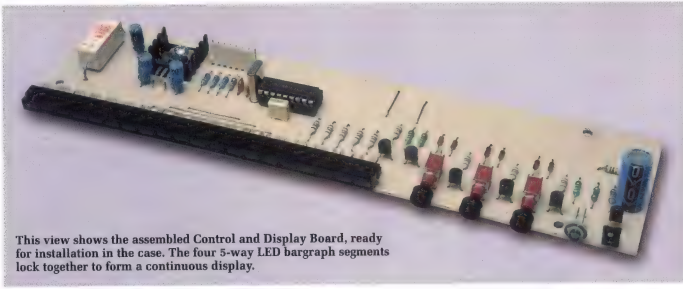
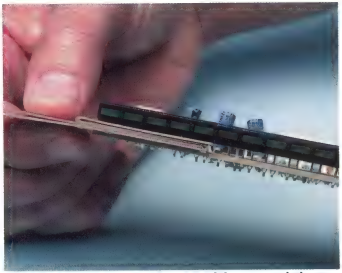


Fig.9: the parts layout for the control and display section. Refer to the text when installing the LED displays.



This view shows the assembled Control and Display Board, ready for installation in the case. The four 5-way LED bargraph segments lock together to form a continuous display.



The LED bargraph segments must each be mounted about 2.5mm proud of the PC board and this can easily be done using some folded cardboard to act as a spacer.

installing it so that it lines up with the bargraph LEDs. Similarly, the infrared receiver (IRD1) is mounted by first bending its leads down at right angles close to its body, and then down at right angles again before soldering it to the PC board. The front of this device should be about 1mm out from the front edge of the PC board when it is installed.

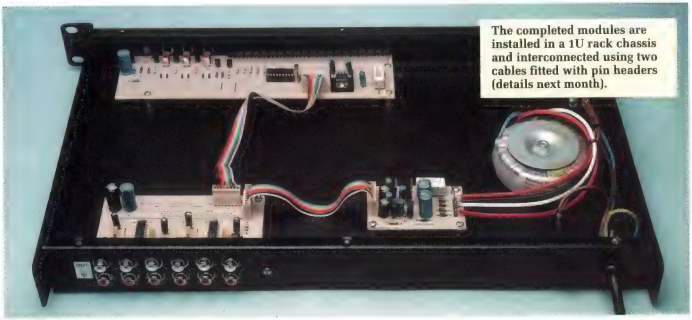
The Display Board can now be completed by installing IC1 in its socket. Make sure that it is correctly oriented.

Power supply board

This board is assembled as shown in Fig.8. The main thing to watch out for here is that you use the correct 3-terminal regulator at each location and that the regulators are correctly oriented – their metal tabs all go towards the 1000µF electrolytic capacitors.

Note too that diode D5 faces in the opposite direction to diodes D1-D4. The 33Ω 5W resistor should be mounted about 3mm proud of the PC board to aid cooling.

That's all for now. We'll complete the construction and give the test procedure in next month's issue. **SC**



The completed modules are installed in a 1U rack chassis and interconnected using two cables fitted with pin headers (details next month).

PRODUCT SHOWCASE

eLabtronics launches icon-based micro assembly language at WCIT2002

Traditionally, microcontrollers have been programmed using a complex, error-prone assembly language. However, a South Australian based microcontroller company plans to change this with its "bitset" icon-based assembly language.

eLabtronics will officially launch bitset worldwide at the World Congress on IT (WCIT2002) to be held in Adelaide from 25 February to 1 March. eLabtronics Technical Manager Miroslav Kostecki will present bitset at the WCIT2002 Business Forum.

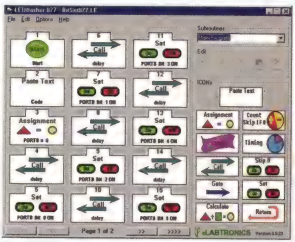
The program itself consists of 10 icons which can be used in any combination to form the total microcontroller instruction set. It makes microcontroller programming simpler, faster and less prone to error, without compromising the controller's speed or the program efficiency.

bitset is set to be used at all levels of education, giving students the opportunity to learn the basics of microcontroller programming at a much earlier age. In fact, bitset is so simple to use that an eight-year-old child was able to use it to program his own burglar alarm.

bitset will narrow the "great digital divide" by providing greater accessibility to microcontroller programming.

eLabtronics CEO Peng Choo said: "The bitset program has huge implications for Australia and will help establish its reputation as a major ICT innovator".

The company's display at WCIT-2002 will feature a robotic arm which has been entirely programmed by students using the bitset program.



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True RMS Clamp-On Hi-Tester

Nilsen Technologies has introduced a true RMS clamp-on meter, the Hioki 3280-20 Clamp-on HiTester. Its compact design makes it possible to securely clamp in even complicated circuitry due to its core thickness of only 9.5mm.

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Tandy have one too . . .

Elsewhere in this issue is a D-I-Y RIAA preamp project, intended to fit into existing turntables.

Not to be outdone, Tandy Electronics have just put on "special" (until 10th March) a turntable with a built-in preamp (presumably RIAA).

The whole deal – "Optimus" turntable AND preamp – is selling for $99.00 (save $30). It is available through any Tandy Electronics store. (Call 1300 728 075 for locations). **SC**

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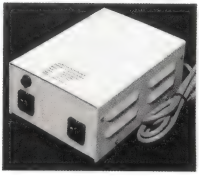

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RIAA Recording Industry Association of America

PREAMPL
FOR TURN

Did you want to build the Ultra-LD Amplifier described recently in SILICON CHIP? Are you put off because it does not have a preamplifier for a magnetic cartridge? Then don't be because this self-contained preamplifier has been designed to install under your turntable and give better performance than the RIAA preamp in most stereo amplifiers and receivers.

By LEO SIMPSON & ROSS TESTER

Seemingly, no sooner than the print was dry on the December 2001 issue which featured the second article on the Ultra-LD Amplifier, than we had several requests for a magnetic cartridge preamp to go with it.

What to do? This had not been part of the game plan: there is really not enough space inside the amplifier for a preamplifier. We were also concerned about being able to obtain a sufficiently good signal-to noise-ratio, if it was somehow packed into the rear compartment of the amplifier.

Of course, one neat solution would be to build the LP Doctor featured in the January & February 2001 issues of SILICON CHIP. This not only features a good preamp but it also electronically removes the clicks and pops on vinyl records. Kits are still available from Dick Smith Electronics.

However, as good and effective as the LP Doctor is, many people want just a simple preamp – and that is what we are presenting here.

It comes on a single PC board together with its own power supply, including an encapsulated 20VA toroidal power transformer. It is intended to be mounted inside a standard turntable plinth, either on the underside of the turntable chassis or the Masonite (hardboard) cover underneath the plinth.

The beauty of having the preamp directly underneath the turntable is that the input signal leads are kept to an absolute minimum and that should mean minimum hum and noise. On the other hand, care has to be taken to ensure that any hum and noise from the turntable motor and mains wiring is minimised.

Circuit description

Fig.1 shows the circuit. It uses a LM833 dual low-noise op amp, with one op amp being used in each channel.

The circuit is practically identical to the preamp stage used in the above-mentioned LP Doctor except that it has higher supply rails and higher overall gain.

The higher gain is necessary to raise the nominal 5mV to 10mV signal of a magnetic phono cartridge to the nominal input sensitivity of 500mV required

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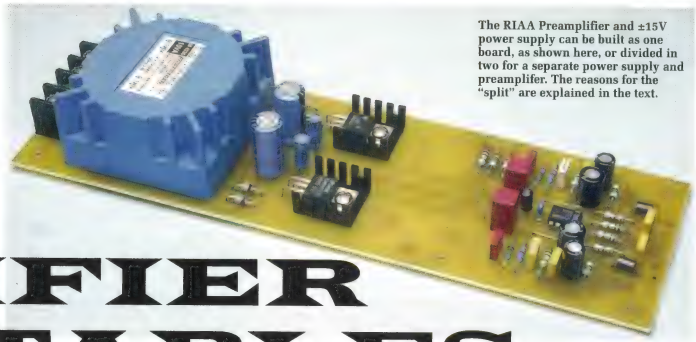


The RIAA Preamplifier and ±15V power supply can be built as one board, as shown here, or divided in two for a separate power supply and preamplifer. The reasons for the "split" are explained in the text.

IFIER TABLES

for full power from the Ultra-LD power amplifier or, indeed, from the "aux" input of most amplifiers.

At the same time, the preamplifier needs higher supply rails in order to provide good overload capability for high level signals from the magnetic cartridge.

For those who have not seen the previous articles on this preamplifier, we will now describe how the circuit works. Both channels are identical so we will just refer to the left channel.

Accordingly, the left channel phono cartridge signal is fed from the input socket via inductor L1, a 150Ω resistor and a 47μF bipolar capacitor to the non-inverting input of IC1a, which is one half of an LM833 dual low-noise op amp.

The inductor L1, 150Ω series resistor and the shunt 100pF form a low-pass filter to remove RF interference signals which might be picked up by the phono leads.

There is also a 270pF capacitor connected directly across the input terminals and this, added to the 100pF filter network capacitor, provides a capacitive load across each channel of the cartridge.

This is done because most magnetic phone cartridges operate best with about 200-400pF of shunt capacitance. Normally, most of the capacitance will be present in the pickup leads from the turntable to the preamplifier input but since this preamplifier is intended to be built into the turntable itself the long connecting leads will not be present.

In fact, if you know the cartridge manufacturer's recommended shunt capacitance you can connect the appropriate capacitor on the board instead of the 270pF we have shown on the circuit. Just subtract 100pF from the recommended capacitance and use that instead of the 270pF capacitors.

While we're still at the input circuit, the 47μF bipolar capacitor looks to be far larger than it needs to be in terms of bass signal coupling from the cartridge and so it is. In fact, as far as bass signal coupling is concerned, the capacitor only needs to be about 0.47μF.

The reason we have specified such a large input capacitor is so that the op amp "sees" the very low source impedance of the cartridge, especially at low frequencies, and this helps to minimise any low frequency noise generated by the input loading resistors.

RIAA equalisation

Due to the way in which vinyl discs are recorded and the characteristics of

Underneath the old Apan belt-drive turntable which had sat, unused and unloved, under the house since CDs came into vogue. The mains terminal strip can clearly be seen centre of pic; the output cables and wires from the cartridge terminate on a tagstrip hidden under the metal shield immediately to the right.

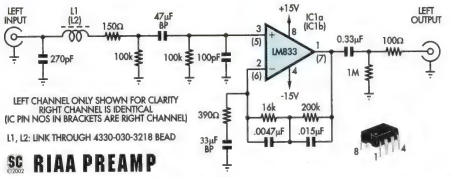


Fig 1: one channel of the RIAA preamp. Gain is set at 56, making it ideal for use with most amplifier "aux" inputs.

typical magnetic cartridges, the input signal to the preamplifier will be very strong at the treble end and becomes progressively less as the frequency drops. To compensate for this, all magnetic cartridge preamplifiers need to substantially boost the bass and cut the treble (ie, equalisation) according to the well-known RIAA characteristic curve.

In our circuit, the RIAA equalisation is provided by the RC feedback components between pins 1 & 2 of IC1a (and between pins 6 & 7 of IC1b, the right channel). In fact, there are three capacitors and three resistors which vary the feedback to provide the correct equalisation. For example, the .0047μF and .015μF capacitors provide the required treble rolloff, in conjunction with the 16kΩ and 200kΩ resistors which help determine the gain.

This feedback network provides the standard equalisation time constants of 3180μs (50Hz), 318μs (500Hz) and 75μs (2122Hz). The circuit also includes the IEC recommendation for rolloff below 20Hz. This is provided by the 390Ω resistor in series with the 33μF capacitor and the 0.33μF output coupling capacitor.

The overall gain of the circuit is set by the 390Ω resistor in series with the 33μF capacitor. This is a compromise between overall gain (set at 56 at 1kHz) and input overload margin. The latter is important because while the nominal signal level from a typical magnetic cartridge may only be about 5mV or 10mV, the level can rise to well over 70mV (or much higher for high- output cartridges).

The frequency response is shown in the graph of Fig.3. Signal-to-noise ratio is about as good as you can get with a typical magnetic cartridge, around -83dB with respect to an input signal of 10mV at 1kHz. The actual signal-to-noise ratio you achieve depends more on your turntable, its rumble performance, shielding from hum fields and so on.

Power supply

To make the circuit self-contained, we have included the power supply. It employs a potted 10VA toroidal transformer with two 15V secondary windings feeding a bridge rectifier, two 470μF capacitors and two 3-terminal regulators to produce balanced supply rails of ±15V.

Both the power supply and the stereo preamplifier have been combined onto one PC board measuring 210 x 65mm and coded 01103021. This has can be used in one piece or split, to separate the power supply and the preamplifier. This has been done to ensure maximum flexibility. While we intended it to be installed underneath a standard turntable, this may not be practical in some cases where space is very limited. In that case, you would need to house the whole PC board in its own earthed metal case.

If you do install the preamplifier underneath your turntable, you will need to take great care in order to get hum-free performance. Generally, that means installing the power supply section of the board as far away as possible from the tone arm and its "arc" across the turntable platter. Typically, this means installing it near the motor or in the opposite corner to the tonearm pivot.

The preamplifier section of the board should then been installed as close as possible to the tonearm shielded cable terminations, typically near the back of the turntable base. Use very short shielded input leads to the preamp and then terminate the turntable's existing shielded output leads to the preamplifier outputs.

Construction

Before starting construction, you will need to make that decision about whether to use the PC board intact, or to split it. While you can saw the board apart after assembly (we did!), it is easier to do before it is populated. And before you do anything, inspect the board for any manufacturing defects.

We'll assume you are going to use it intact but if you aren't, the sequence of construction is much the same. Because the heavier components are mounted at the power supply end, we'll start with the preamp.

Start with the resistors – and as you

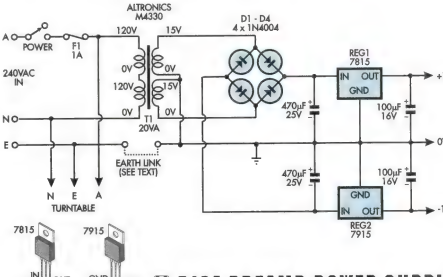
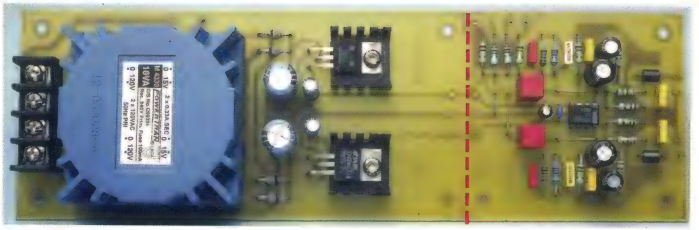


Fig.2: there's nothing particularly unusual about the ±15V power supply . . . except perhaps that "earth link" which is explained in the text.



Here's what the intact board looks like, fully assembled (except for the PC stakes not yet fitted to the preamp inputs and outputs.) The board can be divided where indicated by the dotted line and joined together by 3 wires (+15V, 0V and -15V). Note that there are some minor changes to component values since this photo was taken: the overlay is the latest version.

solder them in and crop their leads, use some of those leads for the four links on the board. The accompanying table shows the colour code for the resistors – some are perhaps unusual, being 1% values (the 200kΩ and 16kΩ, for example). If in any doubt, use a digital multimeter to check them before soldering them in.

Resistor pigtails can also be used for the "inductors", which are simply one pass of wire through the ferrite beads.

Now move on to the non-electrolytic capacitors, which of course are not polarised (note our earlier comments regarding the 270pF input shunt capacitor).

Most of the electrolytic capacitors in the preamp (all bar one, in fact) are "bipolar" types which once again means you won't be caught out with polarity problems. The one exception is the 10μF right across the supply rails which must be installed as shown on the overlay diagram.

There are eight PC stakes to solder in at the inputs and outputs. Originally we had planned to use RCA sockets to make the board as flexible as possible but in the end settled for plain old stakes. Of course, there is nothing to stop you soldering suitable RCA sockets to the stakes, if you wish.

The final component at this end of the board is the LM833 op amp which must mount the way indicated. Solder the pins carefully – it's very easy to get a solder bridge between IC pins. At best, the preamp won't work. At worst, this could destroy the op amp.

Power supply

Just about everything in the power supply is polarised. Start with the four rectifier diodes – they mount in pairs with the two in each pair facing the same direction but the other pair mount in the opposite direction. The direction of these diodes determines which track becomes the positive rail and which becomes the negative rail.

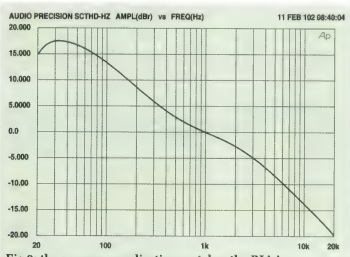


Fig.3: the preamp equalisation matches the RIAA specification very closely.

Next, solder in the four electrolytics with the orientation shown. The larger (input) capacitors face in opposite directions; the two smaller (output) capacitors face the same direction.

The two voltage regulators are different – one is a positive regulator (7815) while the other is a negative regulator (7915). Don't mix them up!

These are mounted flat on the board with the ends of their leads bent down 90° to pass through their respective PC board holes. To get the bend in the right position, loosely mount the regulators to the PC board with M3 screws and grip the legs with fine (needle nose) pliers where the bends should go. Still holding the legs in the pliers, remove the screw and bend the leads down 90°.

The regulators are photographed and drawn with small U-shaped heatsinks fitted. In fact, on the board there is room for much larger heatsinks. Due to the minimal current drain of this circuit, heatsinks are not really necessary – but we have in mind another task for this power supply and preamp later on which will need heatsinks. So we've fitted them. No insulation is necessary between regulator and heatsink.

What is that task? That would be telling!

(Incidentally, if you need a general purpose ±15V supply for other projects, this part of the board is perfect. Is that a clue?)

You will note that there is an earth link shown on the circuit and provision made for it on the PC board. In the vast majority of cases, the turntable itself will be earthed to the amplifier (in turn, earthing the preamp via the input leads), so this link will not be necessary. In fact, it may increase hum levels due to the earth loop formed.

Parts List – RIAA Preamp

1 PC board, 215 x 67mm, code 01303021
1 4-way, PC-mounting mains terminal block, (Altronics P2103 or similar)
2 U-shaped heatsinks
8 PC stakes (14 if separated boards)
2 Ferrite beads, Philips 4330-030-3218 or similar
2 25mm lengths 0.25mm enamelled copper wire
1 240V to 30VCT PC-mounting transformer, Altronics M4330 or similar
1 SPST mains rated switch to suit – neon indicator optional
1 M203 or 3AG safety fuseholder, with 1A fuse.
4 (or 7 for split boards) mounting screws – type to suit use (see text)
Optional: 1 metal case, minimum 75 x 75 x 25mm inside (see text)

Semiconductors
4 IN4004 or similar 1A rectifier diodes (D1-D4)
1 7815 15V 1A positive regulator (REG1)
1 7915 15V 1A negative regulator (REG2)
1 LM833N twin low-noise op amp (IC1)

Capacitors
2 470µF, 25VW PC electrolytics
2 100µF, 16VW PC electrolytics
2 47µF, 16VW PC bipolar electrolytics
2 33µF, 16VW PC bipolar electrolytics
1 10µF, 16VW PC electrolytic
2 0.33µF MKT polyester
1 0.1µF MKT polyester
2 .015µF MKT polyester
2 .0047µF MKT polyester
2 470pF MKT polyester
2 100pF MKT polyester

Resistors (0.25W, 1%)
2 1MΩ 2 200kΩ 4 100kΩ 2 16kΩ 2 390Ω 2 150Ω 2 100Ω

We used two resistor pigtails soldered "end on" into the link holes. To prove whether we needed the link, it was simply a matter of shorting them together. Hum levels increased significantly, so we left them open circuit. They won't do any harm sitting there like that. If your hum level drops when you check the preamp out later, you need the link soldered.

The final two "components" to be mounted are the mains input terminal block and the transformer. First the mains terminal block: it is a special type designed for mains use with barriers between each screw terminal. Don't substitute a block without this insulation. One strand of wire astray and bang . . .

It's also important which wire of the three in the mains lead goes to which terminal, but we'll cover this shortly.

The power transformer

The transformer for this project was specially chosen for two reasons. First, it is a toroidal type which should mean minimum radiation (and therefore noise) into the preamplifier. Second, it is designed to be mounted directly onto the PC board.

The only problem with this transformer is that the pins for input and output appear identical so you could solder it in back to front. Again, if you get this wrong, the result will be briefly spectacular (and expensive). Read the label on the transformer and check it twice before soldering it in!

The transformer in fact has two primaries and two secondaries, each of which the PC board connects in series. The two 120V primaries therefore become a 240V primary; the junction of the two 15V secondaries is connected to 0V.

While the four pins will hold the transformer in place, a self-tapping screw should be used from under the board to hold it secure, relieving the strain on the soldered joints.

Check your component placement, polarity (particularly that transformer!) and soldering before moving on to the next phase of the project.

Hum and noise minimisation

We're going to put the cart before the horse, so to speak, and briefly mention the physical layout before looking at the wiring.

Earlier, we talked about the physical location of the preamp and power supply. To reiterate, you need to get the power supply (transformer, especially) as far away from the pickup as possible (including the complete arc of the tone arm).

Initially, we left the PC board in one piece and mounted it so that the transformer was very close to the motor. While performance was good we thought it could be better.

So we separated the two parts of the board and mounted the preamp right up close to where the wires emerge from the tone arm. And that dramatically improved the signal-to-noise ra-

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
2	1MΩ	brown black green brown	brown black black yellow brown
2	200kΩ	red black yellow brown	red black black orange brown
4	100kΩ	brown black yellow brown	brown black black orange brown
2	16kΩ	brown blue orange brown	brown blue black red brown
2	390Ω	orange white brown brown	orange white black black brown
2	150Ω	brown green brown brown	brown green black black brown
2	100Ω	brown black brown brown	brown black black black brown

Capacitor Codes

Value	IEC code	EIA code
0.33uF	330n	334
0.1uF	100n	104
.015uF	15n	153
.0047uF	4n7	472
470pF	470	471
100pF	100	101

tio. While we used our Audio Precision test gear to confirm the fact, you could actually hear the improvement.

Even more improvement was achieved mounting the preamplifier in a metal box – we used a small folded aluminium type which itself was earthed to the 0V rail.

We didn't mount the power supply in a metal box (though theoretically this could be the ultimate!) for two reasons. First, we tried various methods of shielding the power supply and couldn't measure any improvement but second, and most importantly, parts of the underside of the PC board are at mains potential and we would have had to take extra precautions in the mounting.

As it was, we were able screw the power supply board directly to one of the plywood surfaces underneath the turntable, completely covering and insulating the "bitey" bits.

Note that the mounting screws are all well away from PC board tracks, which also assists in this regard.

Please, be careful when selecting the location for the power supply. If necessary, use some insulated pillars or stand-offs to mount the board.

Wiring it up

OK, back to the wiring. Fairly obviously, we needed to unscrew the plywood, masonite or other sheet which covers the bottom of the turntable plinth. Most turntables will have similar plinths.

Ours happened to be an Apan belt-drive turntable which had sat unused and unloved under the house since CDs came into vogue.

But its belt was still perfect (they made 'em good in those days!), while the cartridge and more importantly the stylus were in great shape. (You should check out the stylus under a powerful magnifying glass or loupe to make sure its point isn't chipped or worn).

In some turntables, the very thin wiring emerging from the tone arm under the turntable will be terminated directly to RCA or similar output sockets. But the majority will terminate to a tagstrip or block, with flying leads going out through the back of the plinth.

You have to connect the tone arm wiring to the inputs of the preamp. This might be by resoldering them direct, or perhaps using a short length of stereo shielded lead.

Every turntable will be different; you have to make the decision according to yours.

In our case, it was easiest to unsolder the flying leads from a tagstrip, solder those directly to the output pins on our preamplifier and use short lengths of shielded cable to connect from the tagstrip to the input pins.

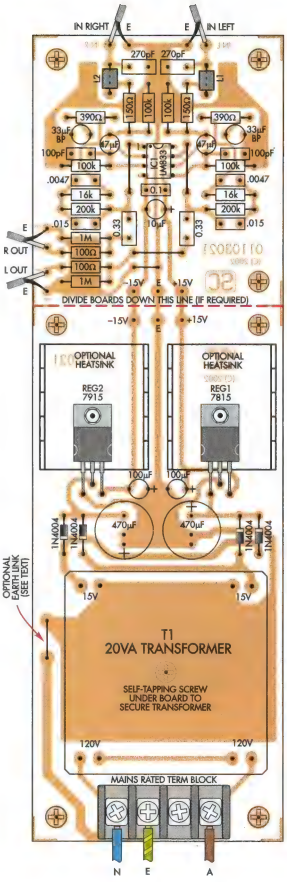
On the mains side, first check and double check that the plug is removed from the wall socket! (Don't laugh, it happens. . .).

Now identify where the wiring comes in and how it connects to the motor.

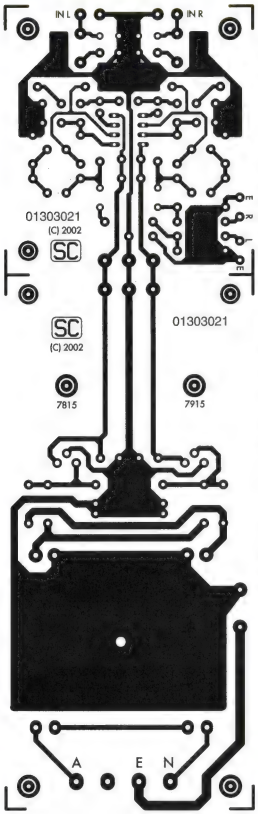
Almost invariably, there is some form of switch (often a microswitch) mechanically linked to the tone arm to turn the motor on and off. You need to cut in before that switch – you don't want the preamp turning on and off with the motor.

There are very few turntables with either a power switch or a fuse, yet we wanted to add both of these so the preamp wasn't permanently left on.

So we traced the mains wiring from the power lead and



Use this diagram in conjunction with the photographs to construct your RIAA Preamplifier.



Above is the full-size pattern for the PC board. At right, this is what your RIAA preamplifier should look like if separated from the power supply. At this stage, we hadn't soldered in any PC stakes.

unsoldered the active (brown or perhaps red wire) and took this directly to a single pole mains switch. From there, we connected another length of cable to a fuseholder and yet another length back to original "active" termination on the tagstrip.

We used a neon-indicator mains switch which necessitated connecting a length of blue mains-rated cable from the neutral terminal on the tagstrip to the neon terminal on the switch.

So far, all we've effectively done is include a mains switch and fuse into the existing turntable wiring.

To connect the preamplifier, we soldered a length of three-core mains lead to the (now switched and fused) active terminal on the tagstrip, the neutral terminal and the earth terminal. This we ran around the inside perimeter of the plinth, secured with cable clamps, until we got to the power supply board.

The outer insulation was removed to a length of about 30mm and the three wires were bared back about 5mm or so. Each was connected to its appropriate terminal on the PC board.

You will note that we have used a four-terminal block for the three wires (Active, Neutral and Earth). This is just a bit of added safety: the Neutral and Earth wires (blue and green/yellow) sit side-by-side – these are nominally at the same potential anyway because they are linked back at your switchboard. The Active wire (brown) is separated from the others by an empty terminal.

Connecting the split boards

Because we (eventually!) decided to separate our two boards, we had to connect them together again. Provision is made for this on the boards.

Solder another six PC stakes into the –15V, 0V and +15V positions on both boards and use a suitable length of cable, secured around the inside perimeter of the plinth, to connect them.

Colours of the cables are not particularly important as long as the same colour connects the same points on each board!

And there you have it. All of those black vinyl things (which many children today don't even recognise!) which have been sitting in your cupboards can now be enjoyed once again.

Oh, by the way – the outputs of the preamp simply plug in to one of your unused "aux" or similar inputs on your stereo amplifier. Sometimes they are labelled "line in".

And if at some time you want to use your turntable with an amplifier that **does** have "phono" inputs, don't be tempted to use them with this preamp in circuit. Apart from probable massive overload, you'll end up with double RIAA equalisation. Not a good sound at all. . .

Enjoy!

SC

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VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

The AWA 719C Console; Pt.1

During the 1940s, AWA produced some very impressive sets and some of the best were the 7-band radio receivers. The first models were produced in the early 40s but arguably the best were produced after World War II.

An overview of the various 7-band models was given in the May 2001 issue. In this article, we'll take a close look at one of the magnificent console models, the 719C, and the work involved in restoring it to its former glory.

This particular set had had a rough life. It's obviously had rodents as house guests at some stage and there had also been considerable cabinet damage due to moisture and exposure to the elements.

With care and patience, it has now been fully restored as shown in the accompanying photographs. Now I have to admit that I didn't do all the work – although I am quite happy when it comes to restoring the electronic circuitry, I am no expert at quality cabinet restoration. So, once I'd removed the chassis and loudspeaker and dial, the cabinet was passed on to a friend, Laurie Tilley, whose woodworking ability far surpasses mine.

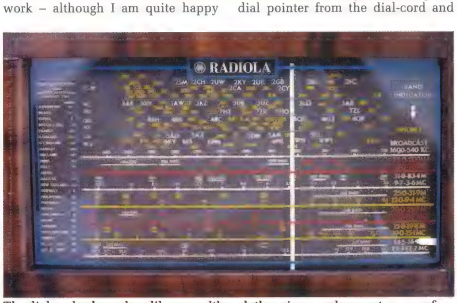
Removing the parts

Removing the chassis from the cabinet is a tricky job as the dial-scale/band indicator is attached to the cabinet itself and not to the chassis as in most sets. This little design quirk leads to other problems, as will be explained next month in Pt.2 of this article.

It is first necessary to unclamp the dial pointer from the dial-cord and remove the band-change indicator cable. If this isn't done, it's possible to damage the dial-drive system. Next, the extension shafts that go through the right side of the cabinet and attach to the band-change and tuning control shafts are removed. The dial-lamp cable and the speaker cable are then unplugged, after which the three knobs on the front panel are removed, followed by the four bolts securing the chassis.

Because I wasn't restoring the cabinet myself, I also removed the loudspeaker and baffle-board from the lower section of the cabinet. The baffle-board is held in place with six wood screws, together with large felt washers and sleeves. These help prevent cabinet vibrations which could affect the stability of the local oscillator in the front end of the receiver.

The dial-scale assembly was removed by undoing the four screws situated at the corners of the assembly. It was then carefully placed to one side, so that it would not get broken. The whole procedure sounds complicated but it isn't – just time consuming.



The dial-scale cleaned up like new although there is some damage to some of the markings for the shortwave bands.

The big clean up

The next task was to thoroughly clean the chassis. As mentioned earlier, rodents had made their presence felt but fortunately, the damage was only cosmetic on the outside of the chassis and there was no damage to the components. Although the exterior is now clean, areas of rust and other corrosion are evident and do detract from the appearance.

As can be appreciated, completely dismantling a set of this complexity to fully restore the chassis is not something to undertake lightly. Nor were the owners keen to spend the extra money needed to return the chassis to

pristine condition.

The 50 years of felt-like dust that had accumulated at the front of the speaker was removed. It is amazing how much dust can accumulate in a spot that is largely "covered" and is due to the loose weave used in speaker cloth.

At this stage, I lubricated all the moving surfaces with light sewing-machine oil. These parts included the control shafts, dial pulleys, switches and the dial pointer slide. Many of them had become difficult to operate due to gumming up and the ingress of dust. All now operate quite smoothly.

Next, the dial-scale was carefully washed and the dial-pointer repainted white. Before washing the dial-scale though, I tried washing a small section of the print in an inconspicuous spot, to make sure it wouldn't come off. In this case, the print remained in place – unlike some I've tested where the dial markings are starting to fall off without even touching them.

My advice is to be very careful when cleaning dial-scales on the side where the print is. If just dusting cleans a dial-scale sufficiently, don't do any more as dial-scales are hard to replace.

Unfortunately, the dial-scale on this set does have some damage on the shortwave bands, as is evident from the photograph. This damage was present before any work was done on the dial and is not due to cleaning.

Apart from this, the dial-scale came up like new. The same goes for the valves, which were also removed and cleaned with soapy water. When cleaning octal valves like this, the trick is to keep the them upside down – that way, the glass envelope can be cleaned without water getting into the base.

Make sure that the type numbers don't get rubbed off during this process – clean the valves gently. Clean valves really do look nice when reinstalled in the chassis.

First looks

Before really starting a circuit restoration, I like to have a good look at the set to see what needs attention. It is best to determine early whether there are likely to be any faults that are expensive to correct, such as a burnt-out power transformer or any other obviously distressed components. In this set, some work had been done in the past to replace the original

The AWA 7-banders are extremely good performers and have an impressive cabinet. In this case, the cabinet came up looking like new.

electrolytic capacitors (the old ones had been left in-situ but disconnected from the circuit).

I find that a headset magnifier is quite an asset when checking into the works of a set as complex as a 7-band AWA receiver. They sell for around $30, while an illuminated magnifier is also available at over $100. I prefer the headset magnifier. as it is easy to move around the chassis, and use a lead light of some sort to illuminate the area of interest.

Getting back to the set, most of the black "moulded mud" paper capacitors appeared to be in remarkably good condition. Conversely, some of the wiring looked a bit the worse for wear, having perished over the last 50 years, and this included the high-tension wiring and AC input wires to the power transformer. In fact, the transformer would definitely need attention before any power was applied to the set.

Both the mains cord and plug had been replaced at some time but neither was in good order. What's more, the PVC twin flex cord used was not in keeping with the vintage of the receiver.

Overhauling the circuitry

The first item to receive attention was the power transformer. I began by using my 1000V insulation tester to check the integrity of the insulation between the mains input and earth and to the other windings. The secondary HT winding was also checked by removing its centre-tap from earth and then testing to earth. The resistance in each half of the winding was also checked using an ohmmeter and they were both the same.

Having done those tests to prove that the transformer itself was in good order, it was time to replace the perished wiring. First, the terminal location of each wire emerging from the front (or chassis) side of the transformer was noted on a piece of paper, along with the colour of each wire.

This done, I removed the two mounting bolts from the front of the transformer and the two bolts which

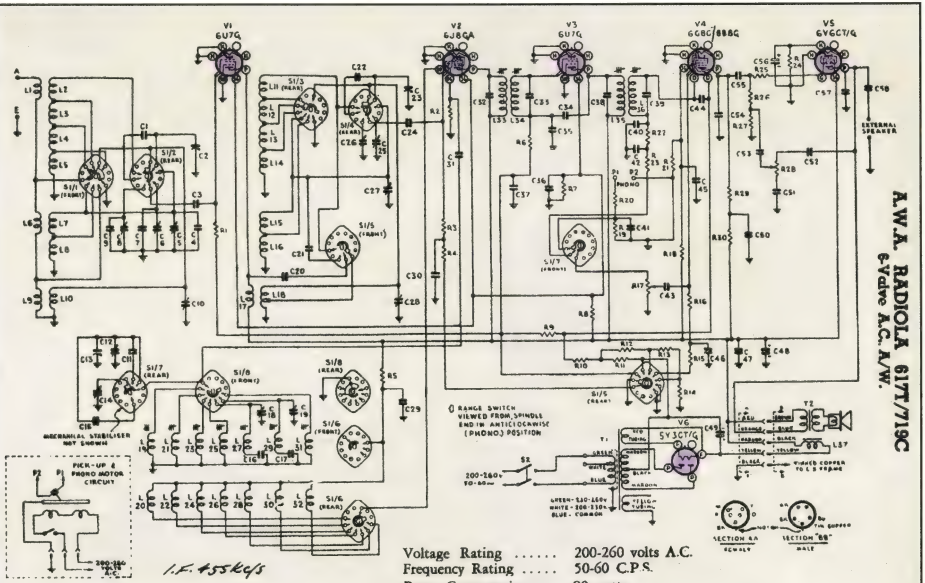
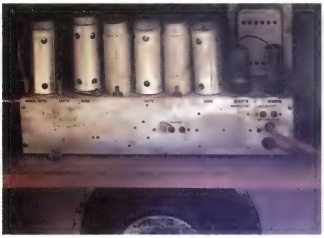


Fig.2: the set employs a 6-valve superheterodyne circuit with a multi-pole rotary switch for the band switching. Alignment is a complicated procedure but is necessary for top performance.



There's plenty of room in the back of the cabinet for the chassis. The loudspeaker fits in the cabinet immediately beneath the chassis shelf and is just visible at the bottom of the picture.

clamp the transformer together, without removing the transformer from the chassis. The front covering plate was then removed so that the high-voltage wiring was exposed. Each wire was then individually removed from its termination and replaced so that no wiring errors could occur. The transformer was then reassembled.

The next step was to replace the leaky paper capacitors. As mentioned earlier, most of the black "moulded mud" paper capacitors were quite OK when tested with the high-voltage tester. However, some had previously been replaced with Ducon capacitors which had now gone leaky and these were all changed.

The resistors were all within tolerance and none required replacement.

Mains cord

As mentioned earlier, the mains cord fitted was not in keeping with sets of this vintage. As a result, I decided to fit a new 3-core brown fabric-covered mains lead, which would be similar to the style of lead originally fitted. The mains plug was in poor condition and so this too was replaced. I used a modern plastic plug and although it doesn't have a vintage appearance, it is safe.

The chassis-entry grommet for the mains lead had perished, so this too was replaced. In addition, the lead was securely clamped to the chassis – it's no longer permissible to tie a knot in the power lead after it enters the chassis, as was common some 50 years ago.

As a further safety measure, the earth lead of the power cord was soldered to a lug which was securely bolted to the chassis. As originally manufactured, this set didn't have an earth wire in the mains lead and the chassis wasn't earthed.

The dial cord was also the worse for wear, so a new cord was fitted. Fig.1 shows how this is done. The original 1mm-diameter (approx.) dial cord required two turns around the dial driveshaft to ensure an effective grip. However, I generally use 0.7mm cord so I put three turns on the dial driveshaft just to make sure.

This works well and the dial mechanism is much freer than on many sets I've come across. It even has a flywheel on the drive shaft so that the set can be rapidly tuned from one end of the dial to the other.

A number of the insulated wires within the set had perished, so these were replaced one at a time. Finally, a check was made with an ohmmeter to verify that there were no short circuits, particularly on the HT line. This all checked out, so it was time to start the testing procedure.

Firing the set up

Power was initially applied to the set with all the valves removed. The AC voltages out of the secondary of the transformer were then checked and found to be a little high. This was to be expected because, with the rectifier valve removed, there is no load on the transformer. I let the set run like this for about 30 minutes and the transformer stayed cool, indicating that it was in good order.

The set was then turned off, the rectifier and speaker plugged in, and the mains switched on again. The HT rose to nearly 500V, which is normal with no load in these receivers. The set was then switched off after a few seconds and the electrolytics allowed to discharge.

This was done several times to "form" the electrolytic capacitors and they remained cool during this procedure. The time taken to discharge increased with each on/off cycle, indicating that the capacitors had "formed". Being relatively modern capacitors, they appeared to be quite OK right from the word go.

By the way, it's always a good idea to go through this routine as the electrolytic capacitors may be badly in need of "forming". If the HT is simply applied and left on, the capacitors may overheat and explode. They may also cause the rectifier to be severely overloaded. However, short term overloads rarely cause a problem and the capacitors will usually quickly "reform".

At this stage, all the valves were replaced in their sockets and the set again turned on. A quick check with the multimeter revealed that all voltages were nominally correct. However, after some time, the HT decreased due to the fact that the 5Y3GT rectifier had come to the end of its useful life. A replacement valve soon fixed that problem.

Next, an aerial and earth were con-

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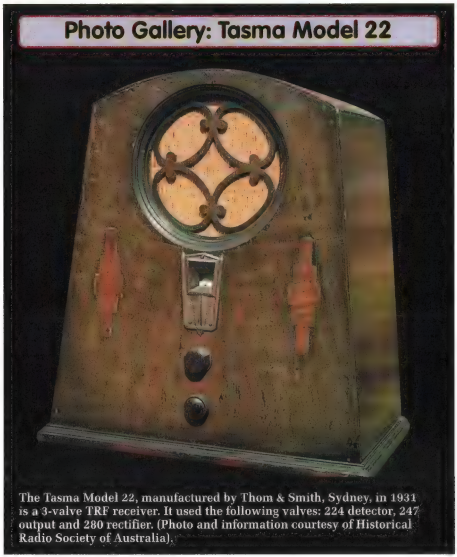
Photo Gallery: Tasma Model 22



The Tasma Model 22, manufactured by Thom & Smith, Sydney, in 1931 is a 3-valve TRF receiver. It used the following valves: 224 detector, 247 output and 280 rectifier. (Photo and information courtesy of Historical Radio Society of Australia).

nected to the receiver, as it was time to tune around and see whether the set was in working order. I switched to the broadcast band and found a number of stations. 3GG on 531 kHz is a good test where I live, being a 5kW station with a directional antenna some 200km away. If the signal is loud and clear from this station, I know that the set being tested is in good order.

Crook grommets

There was one problem – the tuning gang mounting grommets had perished and so the gang wobbled around. Unfortunately, unless the coil sub-assembly is dismantled (a major job), it isn't possible to directly replace the grommets.

To get around this problem, I began by cleaning all the hardened rubber out from around the two mounts near the dial drum. I then slit a gang-mounting grommet through its slot, so that I ended up with two rubber washers. These were then cut so that they could be opened out and slipped around the metal gang mounting posts near the dial drum

A small screwdriver to was used push each half-grommet under each flat near the metal mounting posts. They were then secured in place by applying some glue to their outside edges and the chassis. Each half-grommet now provides some support for the gang and there is some give on the mount.

Alignment

Alignment is quite a task with the AWA "seven-banders" and the 719C is no exception. In fact, I gather that most owners of these sets tend to shy away from aligning them and I can't say I blame them.

That said, they are excellent sets and it really is well worthwhile going through the alignment procedure, to get the best out of them. I'll walk you through the alignment steps in detail next month.

Assembling the receiver

While I'd been solving the circuit problems, Laurie Tilley had been restoring the cabinet as near as practical to its original condition. It looks good, as the photograph shows, and the owners are happy with the their family heirloom.

Once the cabinet had been returned, the speaker and baffle were replaced and the six 50mm mounting screws (along with the felt washers and sleeves) were installed to hold the baffle in place. It really is quite an elaborate system to ensure that baffle vibrations are not transferred to the oscillator tuning components and thus cause instability.

The dial-scale and then the chassis were also refitted to the cabinet. The dial-scale has four small screws and the chassis has four larger metal thread bolts holding it to the cabinet shelf. The dial-scale clamp was then re-attached to the dial cord and the band-change bowden cable was reattached to the band-change drum.

The position of the bowden cable within its clamp allows for some adjustment of the band indicator behind the dial glass. Finally, the extension shafts for the band-change and tuning controls were installed, the knobs fitted and the loudspeaker reconnected.

I timed myself doing this job and it takes almost 30 minutes. This included adjusting the dial pointer position and the band-change indicator. As a matter of interest, I later tested myself on a much simpler Precedent mantel set and it took me just 60 seconds to do what had taken half an hour on the AWA set!

Disaster strikes

Once the assembly had been completed, the set was given a final performance check to make sure everything was OK. The clamp on the dial-cord was then adjusted so that the stations appeared in their correct positions on the dial.

By this stage, the set was going nicely and I was admiring the cabinet and its performance when it suddenly stopped working. So what had gone wrong?

The grid of the first audio stage (6G8G) comes out to a top cap and so, using a time-honoured technique, I touched it with my finger – all I heard was a thin squeak rather than the expected healthy "blurt". I tried another 6V6GT audio output valve but it made no difference. And that meant that the set had to be dismantled again, so that I could find out where the fault was.

Once I had it dismantled, I tested around the audio section and found no problems. Then a small sliver of wire fell out of the wiring – a leftover from a snipped component lead. Perhaps it was this that was causing the problem but, despite shorting various sections, I couldn't reproduce the symptoms originally observed.

In the end, I concluded that this had to be the answer so the set was reassembled. It worked well for a while – then stopped again. I advanced the volume control and the set suddenly burst into life. This is usually a sign of a bad connection somewhere, either a dry joint or a corroded or poor joint inside a component. At least I was starting to narrow down the source of the problem.

It was time to get serious about finding the problem. Often, with intermittent faults, the best approach is to connect the appropriate test equipment and then just wait for the fault to show. In this case, I connected my DMM (set to the 400V range) to the plate of the 6G8G, to measure the plate volts under normal and fault conditions. I also connected an audio signal tracer to the grid of the 6V6GT to see if audio was getting this far without trouble. Note: for safety reasons, it is necessary to switch the set off when changing the test instrument test points.

Next, I adjusted the volume controls (at low level) on both the set and the signal tracer for the same volume. After a while the set went quiet but the test instruments showed no change.

I then connected the DMM to the plate of the 6V6GT and connected the signal tracer to the same spot. When the fault reappeared, the plate circuit of the 6V6GT was still operating correctly, with both the voltage and the audio the same as before the fault.

I then moved the speaker and the fault came and went (this had had no effect previously). Careful inspection using the headset magnifier revealed a dry joint on the hum bucking coil on the speaker. The joint was resoldered and the radio now operates reliably for the first time in 50 or so years.

Photo Gallery: Airzone Model 300

Manufactured by Airzone, Sydney, in 1934, the Model 300 is a typical Australian "cathedral" style set. It is a 4-valve superheterodyne set with the following valve types: 57 autodyne mixer, 50 amplifier, 59 anode bend detector/output and 80 rectifier. (Photo and information courtesy of Historical Radio Society of Australia).

Summary

As mentioned, aligning this receiver can be quite a chore. The "7-banders" are all slightly different in their alignment details and dial glasses, which means that the precise details for a particular model are needed if accurate alignment is to be achieved.

Unfortunately, very little alignment data is available, except in Volume 6 of the AORSM manuals. However, I have been thoroughly frustrated by the published alignment instructions and the errors that have crept in.

In the end, I developed a method that is relatively easy and is as accurate as possible for all models.

The AWA 7-banders are expensive receivers to service, especially if you want to achieve the best performance possible. The performance is (as expected) extremely good and the cabinet is impressive and really looks the part in the lounge room.

The tuning range covers 530kHz to 22.3MHz in seven bands. It has bandspread on the higher frequency bands and has a tuning mechanism that is very free, which makes tuning a dream compared to a normal dual-wave set covering nearly the same tuning range.

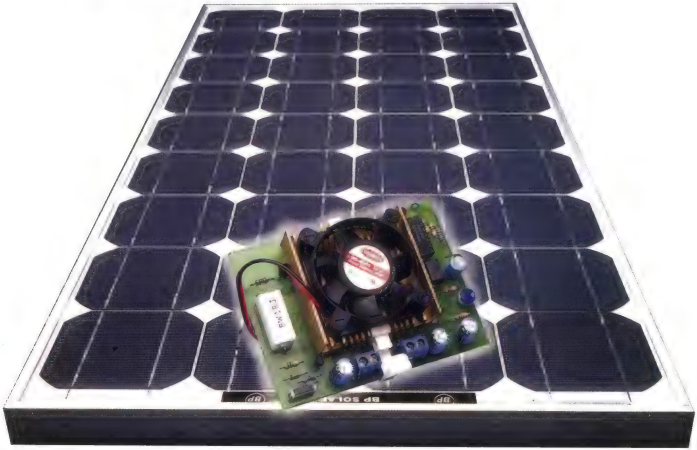
In summary, the AWA 719C console is a highly sought-after radio, with impressive performance, ease of tuning and a high price tag. If you have the room to display one of these radios, go for it. **SC**

Higher Intelligence:

Solar Power Battery Charger

By Ross Tester

Elsewhere in this issue there is a feature which doesn't portray grid-connected solar power in a particularly good light. To show that we're not against solar power *per se*, here's an intelligent battery charger specifically intended for storage-type solar power systems.



There are many people across Australia, nay, around the world, who rely on "free" power from the sun, courtesy of the solar cells mounted on their roofs.

For many of those, solar power is their only source of power: typically, these are people who live too far away from the electricity grid to make connection economic. For them, the somewhat questionable economic returns of solar power don't come into the equation: if you want power, you have to make it yourself.

As we mentioned in that feature, the basic choices are hydro, wind, bio-mass or solar. And while there are plenty of micro-hydro systems, wind generators and even some small-scale bio-mass systems, by far the largest percentage of people opt for solar power.

However, there are many others, city and country who, for many reasons –environmental, experimental, (or perhaps just plain mental!) have decided that they too would like some of this "free" power.

The main difference between solar power in the suburbs or towns and remote solar power is the way the power is used when it is generated. Where increasing numbers of city dwellers with solar power these days probably have "grid-linked" systems, invariably, remote solar power generators must use some pretty muscly batteries to store the power when the sun is out, ready for use when it is (a) needed, or (b) dark/cloudy/rainy/etc.

Typically, banks of storage batteries are used. In the past, a lot of people have used (expensive!) traction-type batteries (eg, fork-lift, etc) because these are designed to be deep cycled.

Such treatment destines your typical car or truck battery to a very short life.

In recent years, batteries have come onto the market which are specifically intended for power storage (eg, solar power) applications.

Most systems use series and parallel connected batteries to give both high current and high voltage (well, higher than six or twelve volts!) systems.

The reason for this is mainly in the higher efficiency of DC/AC inversion from a higher voltage and lower I^2R losses in the system. 24V is common, as is 48V. Above this, though, you could start to get into difficulties with running from 12V solar cells.

That's not to say a 12V battery system is not perfectly practical; in fact, you can use a commercially-available 12V/240V (or more usually 230V) inverter and save a lot of hassles. Some of these are very efficient, these days.

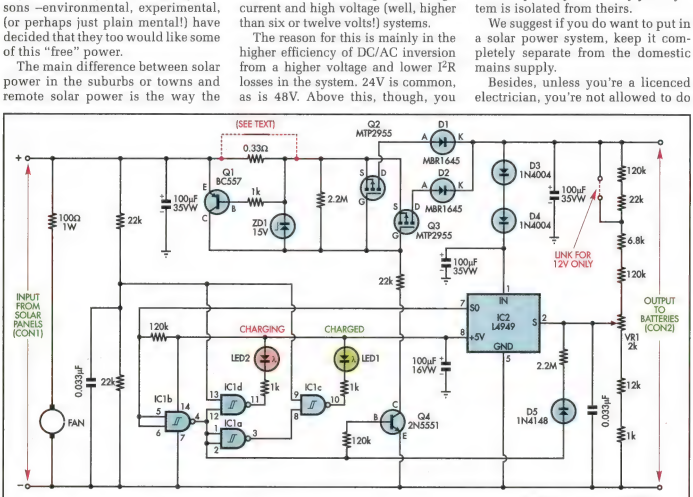
And we aren't saying that anyone in the middle of suburbia shouldn't put in a solar power system, if that is your want. Whether you want to save the planet or not (or perhaps you've come across some cheap solar panels!) you have every right to put in your own system.

Where the situation does become a bit muddied is when you want to connect your solar system to your home wiring, using existing power outlets and so on.

The power authorities have some pretty strict rules about how this is done, especially in the way your system is isolated from theirs.

We suggest if you do want to put in a solar power system, keep it completely separate from the domestic mains supply.

Besides, unless you're a licenced electrician, you're not allowed to do



INTELLIGENT SOLAR CHARGER

The intelligent charger is built around a specialised IC, an L4949 made by On Semiconductor. It can suit 12V and 24V systems.

anything with your home wiring. But that's another story in itself!

Charging the batteries

Having invested sometimes thousands of dollars in batteries, it is important to "treat them right" to maximise not only their life but also the power you can store in them and get from them.

"Treating them right" means not only the way they are stored (eg, batteries don't normally like being placed directly on concrete floors), maintained (eg, distilled water level where appropriate) but also in the way they are charged and discharged.

It has been fairly common practice to simply connect the solar cells in series with the battery, usually via a series diode to prevent the battery discharging through the cells when they're not producing power.

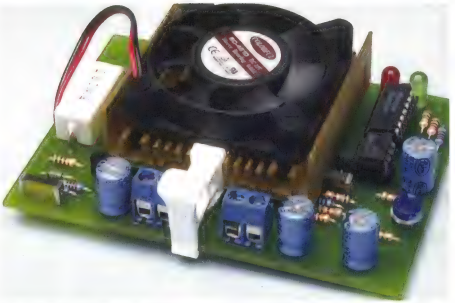
As the solar cells are essentially a constant current device, this is not a real problem when the batteries are either fully or partially discharged.

However, it is not good for the batteries when they are charged. The solar cells don't know this and they keep on pumping out power while ever the sun shines. Result: overcharged batteries.

This will certainly lower the battery life – and that's why you need a regulator. It senses the state of charge: while the batteries are less than fully charged, it allows the solar cells to pump in as much power as good ol' Sol will allow. But when they are nearly charged, it starts throttling back the electrons so the battery won't overcharge.

Circuit operation

This circuit is designed for either 12V and 24V systems with the changing of just one link.



Larger-than-life view shows the input and output connectors at the front of the PC board along with the (optional) fan. This fan should not be needed for solar panel systems (a small heatsink will suffice).

At the heart of the circuit is IC2, an L4949 monolithic integrated 5.0V voltage regulator with a very low dropout voltage and additional functions such as power-on reset and input voltage sense. In this circuit we use the 5V regulator because of its extremely low quiescent current. When there is no power source (ie, solar cells) connected, the total current drawn from the battery is around 300uA. We also employ the voltage sensing comparator section of this IC as the main switching device with hysteresis. The power-on reset circuit is not used.

Incidentally, a specification sheet for this IC can be found at the manufacturer's (ON SEMICONDUCTOR) web site:
www.onsemi.com/pub/prod_0,1824,productsm_ProductSummary_BasePartNumber%253DL4949,00.html

Instead of typing all that, it is probably easier to search for L4949 at google.com as it will be the first item to come up, in less than a second!

For the following explanation, assume that there is a supply voltage present at the source (Solar Panel etc), therefore the voltage at pins 9 and 13 of IC1 would be at logic 1.

Pin 2 is the input pin for the battery sensor section of the IC. When the voltage at this pin falls to 1.24V the open collector output pin 8 is pulled internally to ground. This pin would normally be connected in series with a resistor and a Battery Low indicator LED to a positive supply.

In this circuit pin 8 pulls the input of IC1b to logic 0 level via a 120kΩ resistor so the output from this inverting gate would be at logic 1. Since both the inputs of IC1d are now logic 1 the output would be at logic 0 and

LED2 (Red) would light to indicate that the battery was charging.

Because of the inverting action of IC1a, the level at the output of IC1c would remain at logic 1 and LED1 would not light. Q4 is turned on via the 120kΩ resistor and the gates of P-channel Mosfets Q2 and Q3 are pulled low via the 22kΩ resistor. Q2 and Q3 conduct, allowing the battery to charge. A small amount of current is fed by the forward biased diode (D5) and the 2.2MΩ resistor to the voltage divider network, thus effectively slightly increasing the voltage at the sensing pin, (pin 2). The addition of this resistor effectively reduces the hysteresis voltage of this part of the circuit.

When the voltage at pin 2 rises to 1.34V, the internal transistor at the output is turned off and the voltage at the input of IC1b is pulled high (to +5V), again via the 120kΩ resistor. LED2 is turned off and LED1 (Green) is turned on, indicating that the battery is fully charged. Transistor Q4 and the Mosfets are turned off so the charging ceases.

For a 12V battery (LINK2 in) and with the values selected in the resistor divider network and a centred potentiometer, the voltage of the battery being charged will need to reach approximately 14.2V before the charging is stopped.

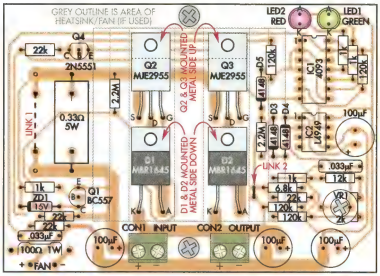
Charging will will resume when the battery voltage drops to 13.7V.

For a 24V battery (LINK2 out), the voltage of the battery being charged will need to reach approximately 28.4V before the charging is stopped. Charging will resume when the battery voltage drops to 27.4V.

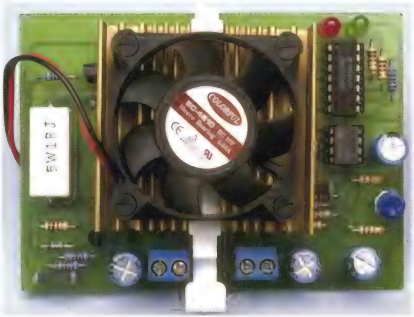
Charging from a supply

While the circuit is designed for use with solar panels, it can (with a minor modification) be used with other sources of power.

Solar panels have a limited current output so it does not matter if they are connected directly across the battery: the current will be similar in value when the battery is "full" or "flat". When this charger is used as a regulator for solar panels, the 0.33Ω, 5W resistor should be shorted with a link for most efficient operation. In this case the only loss is due to the "on" resistance of the Mosfets and the low forward drop of the Shottky diode/s.



Same-size views of the component overlay and matching straight-on photograph. The 3.3W resistor in the pic below is actually in the "Link 1" position – but it doesn't matter 'cos they're in parallel.



However if the charger is used in conjunction with power sources that do not have current limiting (for example a bench power supply or an automotive battery charger) the circuit can be made to current limit by removing the link across the 0.33Ω resistor. When the voltage across the current limiting resistor exceeds 0.6V transistor Q1 is turned on, thus reducing the gate voltage applied to the Mosfets. This serves as a simple constant current source, the value of which equals 0.6/0.33A. To increase the current, reduce the value of the resistor.

To minimise battery drain when the solar panel is not supplying power, the voltage at pins 9 and 13 of IC1 are logic low and both the LED's are at turned off no matter what the state of the battery is.

Two series diodes, D3 and D4, were added to reduce the supply voltage to IC2 by approximately 1.2V. This is necessary for a 24V battery as although the IC has a transient supply voltage of 40V, its maximum continuous supply voltage is 28V.

In each kit are one 10A Shottky diode and two power Mosfets. The total dissipation in the two Mosfets would be approx. 0.15W at 1A, rising to 2.4W at 4A. Doubling the number

Parts List – Intelligent Solar Charger

1 PC board, 98 x 70mm, code K009B (Oatley Electronics)
1 U-shaped heatsink (or fan/heatsink – see text)

Semiconductors
1 4011 quad Schmitt trigger (IC1)
1 L4949 voltage regulator (IC2)
1 BC557 PNP transistor (Q1)
1 MTP2955 P-channel mosfets (Q2) (Can use two – see text)
1 2N5551 NPN transistor (Q4)
1 MBR1645 Schottky diodes (D1) (Can use two – see text)
3 1N4148 small signal diodes (D3-D5)
1 15V 0.5V zener diode
1 Green LED (LED1)
1 Red LED (LED2)

Capacitors
3 100µF 35VW electrolytic
1 100µF 16VW electrolytic
2 .033µF MKT polyester (code 33n or 333)

Resistors (0.25W, 1%)
2 2.2MΩ 4 120kΩ 4 22kΩ
1 6.8kΩ 1 12kΩ 4 1kΩ
1 100Ω 1W (for optional fan)
1 0.33Ω 5W (only required if power supply is used instead of solar panel)

Optional:
1 12V fan/heatsink

of mosfets would reduce this total power dissipation by 1/2.

Increasing the number of Mosfets results in better efficiency but is hardly needed. Other types of Mosfet with a lower "on" resistance could be used (an MTP2955 has an on resistance of 0.3Ω).

As an example a 60W solar panel is rated to deliver approxiamtely 4.3A into a floating lead acid battery (14V). With this panel the mosfets would dissipate a total of about 2.8W. A small heatsink would be necessary but a fan is not.

The fan shown in our photographs is an option, for use when the link is removed and the circuit is used as a constant current source. Here the total dissipation in the Mosfets becomes the supply voltage minus the battery voltage times the current. A 1Ω/1W resistor is supplied in the kit. With this the current is limited to 0.6A, so the dissipation in the two mosfets would be a total of 1.5W for a 2.5V voltage difference (this figure applies when the optional Kenwood plugpack is used).

Construction

With the exception of the (optional) fan, all components mount on a single PC board, coded K009B. As usual, inspect the board before assembly for any defects – shorts between tracks or broken tracks – and if necessary, repair them.

Most of the construction is pretty much standard: start with the lowest profile components first (resistors, small capacitors) and move from their to the larger capacitors (watch the polarity on the electrolytics) and then the semiconductors.

Naturally, all semiconductors are polarised so ensure they go in the right way. Leave the two Mosfets and one or two Schottky diodes for a moment.

Whether you use sockets or not for the ICs is up to you but if you do, be careful to align the sockets the same way as shown on the PC board overlay, and be even more careful to get all the pins in straight when inserting the ICs.

Now's the time to decide what format you're going to build the regulator in – ie, for a 12V or 24V system, and whether it is for solar panels or for use with a power supply.

For 12V, a small link shorts out the 120kΩ and 22kΩ resistors near the lower right corner of the board (leave the link out for a 24V system). Of course these two resistors are redundant and could be left out but for the sake of ten cents, they might as well be included.

The second choice (solar cells or power supply) determines whether the 0.33Ω resistor is in circuit or not. For solar cells, it can be shorted out via a link (left side of PC board) but if you are going to use it on any device without current limiting (or want to make it dual purpose), keep the resistor in circuit (ie, don't solder the link in).

The Mosfet(s) and diode(s) are the last components to solder in. They may look quite similar so don't mix them up! The one or two Mosfets (depending on your requirements) mount at the top of the board with their metal side(s) up – that is, opposite to the way you would normally solder them into a circuit. This is to allow contact with the heatsink.

The one (or two) Schottky diode(s) mount at the bottom of the board (closest to the connectors) and solder in the "normal" way – metal side down.

Finally, solder in the two PC board mounting screw connectors, CON1 and CON2 and the board is finished.

Setting up

To set the charge, you will need to have the 12V or 24V battery connected and the solar panel(s) or power supply connected. You can set it with a power supply and use the same setting for a solar panel but make sure the 0.33Ω resistor is in circuit if you do!

Turn VR1 fully clockwise. Monitor the battery voltage (with a multimeter) and when the battery reaches its correct charge voltage (14.2V or 28.4V for 12V and 24V systems respectively), slowly turn VR1 anti-clockwise until the green LED lights.

Optional fan

If you decide you want to fit the fan (as shown in the prototype) this simply clips over the PC board along with its integral heatsink.

However, as we mentioned, for use with solar panels this fan should not be necessary – a small heatsink will suffice.

The 100Ω resistor on the PC board allows the nominally 12V fan to run from the higher voltage produced from the solar panels (up to 18-20V).

Wheredyageddit?

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Kit/Component Prices

BASIC KIT: PCB and all components but with one Shottky diode:	$21.00
Optional clip-on fan/heatsink:	$4.50
Extra Mosfets:	$3.00
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Battery charger killed a transistor

I would be grateful for your assistance with the Multipurpose Fast Battery Charger Mk2 which was featured in the June & July 2001 issues. I have built this project from a Jaycar kit and on switch-on I unfortunately had a short-circuit caused by a tiny piece of metal swarf trapped behind Q2. I have rectified this and all the tests mentioned in the article measure OK.

However the voltage across the output terminals remains at full (about 18V), irrespective of the position of switch S5. I have replaced IC1 but this has not improved matters. (D. M., via email).

● Almost certainly transistor Q1 has gone short circuit because it would have driven the short-circuited Q2. D2 may be OK but it would be wise to check that it is not also a short circuit.

Questions on harmonic distortion

Can you answer these questions for me with relation to manufacturers' THD figures for audio power amplifiers? If the test is run at, say, 1kHz @ 0dBm into 8-ohm loads and the figure they quote is .01%, is this just prior to the onset of clipping? At what harmonic frequency do they measure the distortion – 1st, 2nd or 3rd? Is the test performed the same way or does it vary, depending on what figure they are after (ie, looks best)? (G. G., via email).

● Generally, the distortion quoted should be associated with the rated power or maximum power (ie, just before onset of clipping). Harmonic distortion or THD (total harmonic distortion) refers to all the harmonics and noise contained in the signal.

Programmable ignition for a Falcon

I realize this may be a bit of a long-shot but I was wondering if there is any known information on fitting the "Programmable Electronic Ignition System For Cars" (from March 1996) to an 1998 EL Falcon. Perhaps you may be able to refer me to some information source on how this may be wired to the existing ECU in the car. (J. P., via email).

● We strongly recommend against trying to use the Programmable Ignition in any late-model car with an existing engine management system. The OEM system monitors quite an array of sensors in order to control the fuel injection, ignition timing and the automatic transmission whereas the programmable ignition only monitors manifold vacuum.

Video sharpening optimisation

I've recently bought the Doctor Video kit featured in the April 2001 issue of SILICON CHIP and I have tried it out a bit. Although the picture was pretty good, it was not quite as good as I would have liked it to be.

In the kit instructions, it says that by varying the 330Ω resistor up or down you can change the amount of high frequency video boosting given by the sharpen switch. What would be the absolute maximum I should vary it or what is the next best resistor value to use?

I also have the same questions about the 82pF capacitor. (P. B., via email).

● The limit to video sharpening comes about when you observe more noise and graininess in the picture. So vary the resistor and capacitor with this fact in mind.

Brighter indicators for rev limiter

I have just purchased the Rev Limiter project described in April 1999 from Jaycar electronics. I want to know if it is possible to replace the indicator lamps with relays to operate a much bigger indicator light, say a 21W bulb,

Upgrading the 100W DC-DC converter

I am currently considering building a couple of your 100W DC-DC converters for car amplifiers, as described in your December 1990 issue. I have a few questions regarding design and component availability.

My first question is where do you get the Siemens EC-41N27 ferrite transformer core, bobbin and case?

Secondly, I would like to know if there is any immediate problem with pulling 50 more watts out of the converter. If I use slightly thicker winding wire in the transformer and inductors (in proportion with the original sizes, of course) and upgrade the diodes, Mosfets and capacitors in the high current areas, I cannot not see a problem. Your comments would be appreciated.

Finally, I would like to use one Mosfet per side of the push-pull network. Can I substitute one BUK456-60A Mosfet for the two MTP3055s, or will this Mosfet not handle the switching speeds required? (T. B., via email).

● The EC41 is difficult to obtain now but the ETD44 should do the job. It will not quite fit into the PC holes but can be made to fit. Also it has a larger area than the EC41 to allow a 55% increase in power.

This part is available from Farnell Electronic Components. Phone 1300 361 005 and ask for the cores 305-6405 (two required), the bobbin 305-6326 (one required) and clips 105-775 (two required).

You can use higher-rated Mosfets instead of two MTP3055 types. BUK456s should be fine.

as I run a race-car and want an indicator that I will notice. (T. M., via email).

● You can replace each lamp with a 12V relay and a diode, with anode to the transistor collector and cathode to 0V; ie, each diode is reverse biased.

Stereo FM Minimitter blows the zener diode

I have purchased a Minimitter kit from Jaycar. I have assembled it and I am having a little problem that you may have a solution for. I have tuned the transmitter to 100MHz, without a sound source. As soon as I connect a sound source, the 3.3V zener diode goes up in smoke! I would like to use this transmitter on my computer to transmit MP3 signals to another radio in the house.

The circuit is powered with 6VDC from the external socket. I am getting the power from the PC using a Low Voltage Adapter Kit (Dick Smith Kit K-3594), as published by EA in August 1997. It basically has 12VDC input shared by a fan, put through the regulator to provide the 6VDC output. I can't find anything wrong there. It provides a very accurate 6.03VDC. The sound source is from the sound card through a 3.5mm headphone jack to an RCA connector.

I have checked and re-checked all components and their orientation. As I mentioned above, the circuit seems to work fine without a sound source. Perhaps the output voltage from the sound card is excessive? However, I have powered the transmitter on batteries with sound and didn't have a problem! (A. P., via email).

● Not knowing the circuit for the DC power supply you are using, it is hard for us to solve the problem specifically. However, you can be fairly certain that the grounding of the power supply (-Ve terminal) is not at 0V as would be the signal ground for the sound source.

You could try disconnecting the ground connection of the signal inputs leads and coupling with a large capacitor (electrolytic 10µF or larger, but ensure correct polarity by measuring with a multimeter). This should prevent the drastic DC current flow between the supply ground and the signal ground.

Using the speed control for light dimming

I am interested in purchasing the DC motor controller kit (K-3070) from Dick Smith Electronics to use as a DC light dimmer. Is it possible to modify this kit to handle higher currents, say 12A. Possibly using a higher current Mosfet and/or heatsink and wiring? (S. B., via email).

● It is not really practical to modify the January 1994 design to get much higher current. Instead, we would recommend the 12/24V 20A speed control published in the June 1997 issue. This is available in kit form from Jaycar. We can supply the June 1997 issue for $7.70 including postage.

Universal power adaptor wanted

I do a lot of work internationally and have a multitude of chargers/power supplies to power laptops, printers, cameras, phone, etc. Everywhere I go I have a different adaptor/lead for each unit which is annoying and takes up valuable baggage space.

Is there a universal power adaptor which I could buy to solve the prob-

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Modified PIC tachometer

I am trying to modify the PIC tachometer described in the April 2000 issue. I want to replace the LED bargraph with high brightness LEDs on flying leads.

It worked fine with the original bargraph on flying leads, with a common earth for LEDs 1-7, another common earth from LEDs 8-10, common signal for LEDs 8-10 and individual feeds for LEDs 1-7.

When the high brightness LEDs were hooked up the thing overheated. I am unsure of the reason for the overheating but suspect that the seven 150Ω resistors need to be substituted with another value. I know the PIC is blown because the first two digits don't function. They do function when the display board is plugged into a functioning processor board but only one high brightness LED lights up. The others may have suffered in the overload.

Any help would be appreciated. (S. N., via email).

● You should be able to drive LEDs off the PC board without problems. We think you have damaged transistor Q3 so that its emitter and collector are shorted.

Alternatively, the commoned anodes of LEDs 9-10 may be shorted to the commoned anodes of LEDs 1-7 on your wiring modification. Note that these anodes need to be separated.

lem? I bought some useful units from Dick Smith Electronics but these provide only standard voltages. Some manufacturers (eg, Canon, Sony) use special voltages; eg, 5.7V and 13V. Would I cause damage if I used a 6V instead of 5.7V and 12/15V instead of 15V? (B. G., via email).

● The most practical approach is to buy a switchable regulated plugpack such as the Cat MP-3030 from Jaycar or one of the switchable switchmode regulated plugpacks Cat MP3420 or MP3031, also from Jaycar. They should also be close enough to provide the 5.7V or 13V you refer to.

Problem with the 6-LED torch

I've just built the DSE kit of the 6-LED torch project from the May 2001 issue. It doesn't work. Actually, it's the second one I've built – the first one works fine so I've been able to compare the two.

I'd just like your opinion. I'm pretty sure the MAX1676 is dead but before I order one from DSE I thought I might check with you first. I've checked my soldering, checked for shorts around the 1676 and for continuity from the 1676 to the rest of the circuit, but haven't resorted to pulling out and replacing resistors and capacitors yet.

I've also done some static resistance checks versus the good circuit and they seem to be OK. I have measured the voltages on the 1676 pins (to nearest .05V). What caught my attention was pin 5 (Vref) which measures 0.25V. Would this indicate a faulty chip? Overall, the faulty circuit is drawing <1mA, so there are no obvious short circuits. (A. F., via email).

● It does appear that the Max chip is not doing its job. You could remove the chip (including carrier PC board) from the good torch and place this in the bad torch to check whether the circuit then works.

Before doing this, check the orientation of the IC. We have heard of some constructors not getting the torch to work because the IC is in the wrong way. Luckily, the chip is not damaged if this happens.

Request for circuit symbol information

If possible, please advise the meaning of the down arrow from the 12V node near C2 to the +12V indicator, as shown in the 12V soldering iron controller circuit on page 78 of the November 2001 issue. My best guess is that this a general indicator meaning that this node should be at the specified value; ie, +12V with respect to the common ground. (D. W., via email).

● The down arrow means that it connects to other parts of the circuit which also require +12V; ie, pin 8 of IC2. This can be thought of as a drafting "shorthand" which avoids the need to show all supply lines joined together on the circuit. SC

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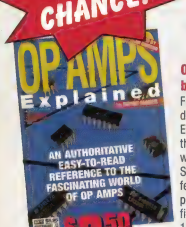

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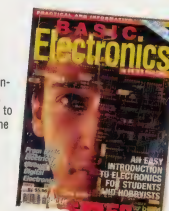

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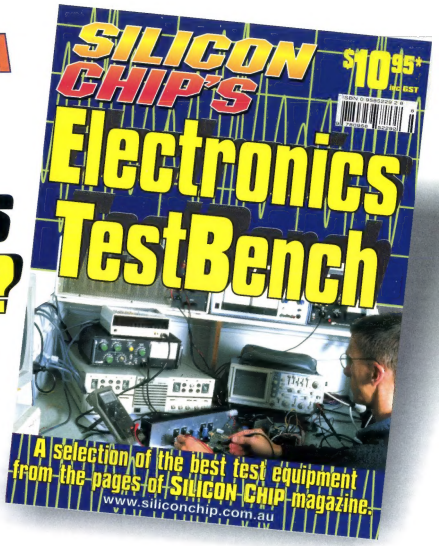

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